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ABSTRACT

The processes and equipment in chemical research and development have become increasingly sophisticated. Accordingly, industry is seeking chemical technicians who have developed an academic and experience base which exceeds that being provided by high schools. This conference is an effort to improve both the quality and quantity of programs for training chemical technicians. Nine presentations, each followed by a critique, concerned (1) the role and functions of the chemical technician in industrial research and production, (2) the curriculum content and institutional role of chemical technician education, and (3) the role of educational institutions and professional associations in programs of continuing education for the chemical technician. Suggested and current chemical technology curriculums are included. (CH)

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PROCEEDINGS

CONFERENCE ON CHEMICAL TECHNICIANS

UTILIZATION

EDUCATION

CONTINUING EDUCATION

December 6 and 7, 1968
Chicago, Illinois

AMERICAN CHEMICAL SOCIETY
1155 Sixteenth Street, N. W.
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TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

INTRODUCTION v

THE TECHNICIAN IN INDUSTRY

Chairman: LeRoy Clemence, ACS Council Committee on Technician Affiliation
The Technician in Research and Development 1
Presentation: Bernard Friedman
Critique: Vincent O'Leary, Black Hawk College
The Technician in Technical Service and Control Laboratories 6
Presentation: Christopher Serauskas, Velsicol Chemical Corporation
Critique: Milan Dubravcic, University of Akron
The Technician in Production 12
Presentation: Richard R. Shreve, Corn Products Company
Critique: Roger G. Garst, Chicago City College

THE TECHNICIAN'S EDUCATION

Chairman: Kenneth Chapman, American Chemical Society
Integrating Chemical Technology with Standard Chemistry Courses 16
Presentation: Norman Peterson, Ferris State College
Critique: J. Fred Wilkes, Dearborn Chemical Company
The Chemical Technology Program at Lorain County Community College 21
Presentation: C. E. Hoffine, Lorain County Community College
Critique: John E. Forrette, Velsicol Chemical Corporation
The American Chemical Society Activities in Chemical Technology Education 30
Presentation: Carleton W. Roberts, The Dow Chemical Company
Critique: R. A. Boehler, Nalco Chemical Company
Summary of Roundtable Discussions on Chemical Technician Education 39

THE TECHNICIAN'S CONTINUING EDUCATION

Chairman: J. Fred Wilkes, Dearborn Chemical Company
The Four-Year Bachelor of Technology Program 43
Presentation: William Lawless, University of Dayton
Critique: David W. Holty, Corn Products Company
Continuing Education Requirements for Chemical Technicians 48
Presentation: Lewis Krimen, Abbott Laboratories, Inc.
Critique: Ronald L. Walling, Milwaukee School of Engineering
Is There a Role for ACS in Continuing Education for Chemical Technicians 53
Presentation: Kenneth Chapman, American Chemical Society
Critique: J. Fred Wilkes, Dearborn Chemical Company
Summary of Roundtable Discussions on Continuing Education for Technicians 60

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The American Chemical Society wishes to express its appreciation to the administration, science faculty, and staff of the Loop Campus of the Chicago City College for serving as hosts of the Conference and providing the assistance which enabled the Conference to function smoothly. In particular, Mr. Herbert Rosing and Dr. Jack Sosinsky earned the gratitude of all the participants through their efforts to handle every need and desire.

The success of the Conference depended upon a strong industrial component. Mr. Fred Wilkes of the Dearborn Chemical Company performed a truly outstanding service in obtaining industrial representatives for formal roles in the Conference and inviting industrial representatives who were able to make contributions as active participants.

The contribution to the success of the Conference made by each formal participant is gratefully acknowledged. However, the final success of the Conference was a result of each participant taking advantage of the opportunity to really participate, not just attend.

Conferences, such as this one, are only made possible through the support of the colleges and technician employers who send their representatives. Although they should benefit by being represented at the Conference, their support is appreciated by the American Chemical Society since it is enabled to be of further service to the chemical community.

Kenneth Chapman
Assistant Educational Secretary
Two-Year Colleges
American Chemical Society

INTRODUCTION

In recent years, a steadily increasing amount of attention has been directed toward the chemical technician. In many places, he has become accepted as an invaluable member of the technical teams undertaking efforts based upon chemistry. Many factors contributed to the expectation that chemical technicians will steadily become more important to industrial and laboratory operations as the science of chemistry advances and automation eliminates routine operations at the cost of increased complexity. To adequately deal with the increasing sophistication of both laboratory and plant, many employers are now seeking chemical technicians that have developed an academic and experience base that considerably exceeds that provided by the high schools.

The American Chemical Society has demonstrated its concern for chemical technicians in several ways. The ad hoc Committee on the Training of Technicians (Chairman, Dr. William G. Young, University of California at Los Angeles) recommended a two-year curriculum for chemical technicians. Using this curriculum as a base, the ad hoc Technician Curriculum Committee (Chairman, Dr. Carleton Roberts, The Dow Chemical Company) prepared a topical outline for the chemistry core content for such a curriculum. Encouragement is now being given to efforts seeking to prepare instructional materials specifically designed for chemical technology programs.

Efforts of the Committee on Technician Affiliation with the ACS (Chairman, Mr. LeRoy W. Clemence, retired from Abbott Laboratories) have stimulated several ACS local sections to begin technician affiliate topical groups. It has sponsored three technician symposia at ACS national meetings and has planned two more (Minneapolis, Spring of 1969 and New York City, Fall of 1969).

These activities have emphasized the potential importance of two-year colleges as a resource for developing technical manpower for the chemical industry. Several two-year colleges have had chemical technology programs for more than twenty years and find that the demand for their graduates is steadily increasing. Many two-year colleges are either planning or exploring possibilities for chemical technology.

The nature of the chemical technology program makes it necessary that good liaison be established between the colleges and potential employers. This is frequently done on a local basis through industrial advisory committees. However, opportunities are rare for an exchange of ideas with a larger group of people experienced in this area. As a result, a Conference on Chemical Technicians was organized for the North Central and Midwestern area of the United States. A most excellent group of participants assembled with nearly equal numbers from industry and academia. These Proceedings are a result of that Conference.

A Conference on Chemical Technicians -- Curriculum Development and Student Recruitment was held in New York in October, 1967 under the co-sponsorship of ACS and the U. S. Office of Education. Copies from a second printing of those proceedings are available by writing to the Education Office of ACS. Problems concerning chemical technology programs were discussed at the November, 1967, ACS Western Regional Meeting. Proceedings from those discussions are available from Mr. Jared Sharon, East Los Angeles College, Los Angeles, California.

THE TECHNICIAN IN RESEARCH AND DEVELOPMENT

Bernard Friedman
Chicago, Illinois

For some thirty years of my career as a research chemist in the petroleum industry, I have had technicians as my personal research assistants. They have been my right arm; they have reinforced my research activities; and they have materially increased my personal productivity. In turn, I think I have contributed to their knowledge, skills and understanding.

Generally, I have had one or two assistants who performed the more routine type of experiments under my general supervision, while I did the exploratory tests, literature searches, research planning, and report writing.

My assistant's job was not a simple one. Often he operated a high-pressure, fairly complicated assembly of equipment -- a miniature refining plant. He ordered the starting chemicals or feedstocks and handled the products. He routed samples to the analytical laboratories, recorded and tabulated the results in our research notebooks, and plotted the data.

If he operated the apparatus with good control of feed rate, temperature and pressure; if he worked steadily, safely, accurately and neatly, I considered him to be a good assistant. If he made recommendations for additional tests, or for revisions of the apparatus, or for beneficial changes in operating procedure, or if he took the initiative to obtain additional background information on our problem, I considered him a very good assistant. When it became apparent that he could handle a research project on his own, I rated him as excellent -- and lost him, of course, as he graduated to the ranks of independent researchers.

In my early years, some of the assistants were high school graduates. The best assistant, however, was one who had had about two years of chemical engineering. (He finally obtained his B.S. degree attending evening classes.)

He was drafted during World War II. The only replacement I could get was a female high school graduate who had had no science courses. Fortunately she was hard-working, talented, intelligent, and learned rapidly. Within a few weeks, she was able to conduct a significant range of experiments (mostly using glass apparatus) -- with the result that our joint output of research during the next couple of years was quite satisfactory.

However, one thing prevented her from having a long career as a technician: she was too good-looking! I lost her to a better man; he married her.

In later years, my assistants have usually been B.S. chemists. This was determined by company policy -- not requested by me. For these bachelor degree people, I have sought to give more responsibility in the planning, evaluating and reporting of the research. A policy of rotating assistants to broaden and diversify their experience was practical. This has meant that just about the time my assistant accumulated the background of experience and knowledge to enable him to participate intelligently in all phases of our research -- he leaves me. Then I must start training a new man.

A B.S. chemist with any ambition at all will not be satisfied with being an assistant. Yes, he will do it for a while to learn the ropes. But all the time, he is yearning to have his own project to work on independently. But he soon finds that he usually will be competing with research chemists who have the advantage of graduate training. If he still persists in his ambition to do independent research, he is apt to take a leave of absence to do graduate work.

Those who are not inclined to independent research tend to have an eye on a future career in sales or in the various administrative posts where there is little or no competition from Ph.D.'s.

In a word, a person who does not have a B.S. degree is more likely to become a career technician, serving efficiently and usually contentedly in that capacity for many years -- thus making it unnecessary for the research scientist to take the time (with the attendant loss of experimental results) to train a new assistant every year or so.

Many other jobs are open to technicians besides assisting research scientists. The petroleum industry utilizes a great many in analytical laboratories, chemicals and plastics testing laboratories, pilot plants and engine test laboratories. Inexperienced technicians start at about $500 per month and get yearly increases reaching the maximum (after 7-10 years) of about $650. In comparison, B.S. chemists or chemical engineers start at about $650-750 per month.

In most companies, technicians are eligible for occasional merit raises. Thus, in one company a few technicians have, by virtue of excellent performance and achievement, reached the $1000 per month level; but these are exceptions. These technician jobs are open to high school graduates, but additional pay is given to those having collegiate training or relevant experience.

The pharmaceutical industry also utilizes a large number of technicians -- in control laboratories, in biological testing, in production, and in research. The starting salary in this industry is about $400 (compared to $500 for the petroleum industry.)

One pharmaceutical firm does something unusual in this field. On occasion, high school juniors (over 17 years of age) -- usually dropouts or potential dropouts -- are given a job opportunity along with some big-brother attention. Here the company is accomplishing two things:

1. It is enlarging its supply of potentially useful manpower.

2. It is doing its share to help disoriented youngsters become self-supporting, productive and happier citizens.

Higher starting salaries and salary increases are given on the basis of growth in skills and experience, and also for academic training over and beyond the high school diploma. Yearly and promotional increments are given until the level of about $700. One company, however, has promoted a few of the more proficient technicians to jobs of greater responsibility paying somewhat over $800 per month.

What about supply and demand? Male high school graduates and those with one or two years of college are, and will be, in fairly short supply. The reasons are:

a) The draft

b) Competition of the trade and building crafts
(e.g. $14,800 for union electricians in Chicago)

c) Urge to get B.S. or higher degrees

d) Expansion of industry

Female applicants are more plentiful. High school dropouts, male and female, are on hand everywhere -- not only in the inner city. Companies can mine that source of talent.

My notion is that semi-professional work (which fills the gap between labor and professional forces) will continue to attract our young people, especially if efforts are made to give these workers some status. The American Chemical Society has taken several steps in that direction:

It has:

1. Created a new staff position at national headquarters, to administer a program to
   a. develop information and statistics on a 2-year college chemistry program
   b. develop guidance and counseling materials
   c. develop general educational resources for chemistry in the 2-year colleges
2. Recommended a basic chemical curriculum for a 2-year course for the training of technicians.
3. Been considering a Journal for Chemical Technicians.
4. Presented symposia at its national meeting, featuring presentation of papers by technicians.
5. Made it possible for technicians to join Local Sections as Affiliates.

During the past two years about 100 technicians have become Affiliates of the Chicago Section. For annual dues of two dollars, they receive a free subscription to The Chemical Bulletin and a discount on meeting dinners. They may hold office in technician groups and serve as Chairmen of Section Committees.

Four-year colleges gain status by affiliation with graduate schools (and some by recruiting good football teams). Two-year colleges which provide training for so many of our technicians have won status by affiliation with business, industry and hospitals. And now they can do it through cooperation with professional societies such as the A.C.S.

CRITIQUE

Vincent C. O'Leary
Back Hawk College
Moline, Illinois

I am very much concerned with the training of chemical technicians. In Dr. Friedman's talk, he has covered the ground rather thoroughly and he is also familiar with the educational program of the schools and the junior colleges. I doubt very much that I can do much more than to point out to you some of the things that he has brought out in this talk.

Throughout the discussion, I had the strong feeling that we are still thinking in terms of transfer programs. This is a term that some of you may recognize. Others of you, who are not in the educational field, may not particularly notice. When they take a program or a curriculum, most students will want to know if it will transfer into a next higher step so that they can aim for a bachelor's degree or a diploma from a college. This seems to have become deeply ingrained. Since the time the student went to school in the first grade, he had teachers who had degrees and they thought that the degree was the ultimate in life's aim. If I am wrong in this, I can stand corrected. Most of our chemical technician programs have had difficulty because we have insisted that all courses and all materials which we taught were to be equivalent to those we have in our programs for majors in science areas, particularly chemistry.

A note that was emphasized here that I liked very well was the fact of the rapport that seems to be a part of Dr. Friedman's relationship with his technicians. I feel this is the key to success with most technicians. The individual who has their services at his command must have good rapport, must keep in touch with the individual technician and continue his technicians' educational process toward those things that they will use in their operations.

Something that bothered me was that Dr. Friedman seems to have been very fortunate in getting people who -- and it is a bad phrase -- have a high intelligence ratio, or good adaptability, if you want to put it that way; IQ is what we call it. This is essential in our area; I will grant you this. We cannot take just any drop-out. We do have to select those drop-outs that have a reasonable chance of success for a career as a technician.

Another thing that bothered me is Dr. Friedman's mention of the union. I do not believe we have very good guidelines at the present time for working with problems in this area. I call to mind one situation. Most of the jobs they have for technicians are unionized and they invite anybody having the appropriate number of years of service to "bump" any individual, regardless of whether he is trained or not.

Another point to which I would like to direct attention is the fact that for good rapport, the researcher trains the technician. Reciprocally the technician trains the researcher to some extent and helps him to realize his shortcomings or his abilities or his capabilities. It is a two-way street. The future of the technician is important because most people do want to advance. This has been borne out in this talk -- the fact that he can advance. I would suggest a second road instead of the first road, that is, through sales management and other areas rather than emphasizing the continuation toward a degree, although this is desirable, and I would not stand in the way of anyone who desired to do this.

The salary factor is one where we do need to come up on our scale. I realize it is difficult to do when we think of an individual with a B. S. degree getting $650 per month, and one with a two-year certificate coming up with $600 per month. Then we talk of a $14,500 per year electrician. I think that in two years, one can get most of the training an electrician needs outside of a few years of apprenticeship that is necessary to go along with it -- maybe a total of three years.

I think supply and demand is the key to the whole thing. We would have more programs in chemical technology or technician type training if we could get individuals to take the program. The reasons that they do not take it really needs investigation. We need to advertise, put out literature, and get to working with the high schools. Frankly, I am still working on the problem, and I am not sure of the answer. I think we must address ourselves to this problem.

Attention for the status situation will help the supply and demand situation. Dr. Friedman mentioned the Searles' experiment of using high school drop-outs. I assume they do screen these people to some extent before they work with them. This is paralleled by a program that Eastman Kodak in Rochester is offering. They are taking people who cannot even read properly and training them to read and putting them into jobs. Not all of them become technicians.

I have not had much contact with research for some years. However, I notice that we do not have much research in junior colleges conducted by the faculty members. This problem is not too great but we must provide the education needed by a technician who may be going into a job for a research group. Can we develop a program that will cover just plain control or analytical work? Should we have three separate programs, or can we work it into one program? How can we do this? How can we give them experience as research technicians?

I had the good fortune to follow Dr. Friedman, but I had written down that one of the problems we have in our chemical technology programs is that they have generally been developed by academicians. They are interested in completely teaching all of the theory. I believe most technicians, once they begin working, have to understand the theory, but they do not need to know it to the depth that we try to teach them. They should be better trained in the practical areas, and we have shortcomings in research for this problem.

We have no research now, but we could have some. In my personal situation, I organized a course and this year I am teaching it. The students were not adapting themselves to it very well. I took them entirely away from the instruments and already prepared equipment and put them to work building their own. I have never liked this very much, but I find that it is working beautifully with these people. They are becoming more adaptable to doing things and they have built such simple things as manometers and pitot tubes and have worked with heat exchange elements. They built their own heat exchangers -- they just found the materials and built them. This type of thing, I think, will help them.

In conclusion, I would like to see us do something to have a concrete program that we can offer over a two-year period which will prepare a person to do a better job as a chemical technician.

THE TECHNICIAN IN TECHNICAL SERVICE AND CONTROL LABORATORIES

Christopher Serauskas
Velsicol Chemical Corporation
Chicago, Illinois

In order to gain a little insight as to why an individual choose to become a technician, I would like to present a background on how and why I made this choice. Also I would like to present my impressions of the work, and of the opportunities both inside and outside the industry for advancing the technician's knowledge as well as his position in the Laboratory.

I graduated from a high school curriculum with the main emphasis on subjects of a scientific nature. After graduation I went to work as a clerk and teller in a bank. I found after a while, that there was no challenge or motivation for a continuing career, whereupon I enlisted into the Navy, and it was here that I made my first choice for a scientific career.

Because of test scores I was offered a choice of one of two basic schools for initial training. One choice was Machine Accounts School; the other, Basic Hospital Corps School. The challenge of the scientific field seemed alluring, and I chose to go into the Medical Corps.

In Basic Hospital Corps School, I gained a general knowledge of patient care, first aid, anatomy and physiology, and the toxicological properties of drugs. It was this latter aspect of my basic training which prompted me to request additional specialized training at the Navy's Pharmacy Technician School in Portsmouth, Virginia.

At the Navy Pharmacy School, I received courses in inorganic and organic chemistry, qualitative and quantitative chemical analysis and a deeper and more meaningful understanding of the properties, dosages and physiologic actions of chemotherapeutic agents as they are used in modern medicine.

After completing this 12 month program, I was assigned to the North Atlantic Fleet where I assumed the duties of compounding and dispensing prescriptions.

My release from the Naval service came with mixed emotion. I was happy to leave the military way of life, but sad to leave the domain of the medico-technological field. Where was I going and what was I to do?

I returned to the bank, to see if perhaps I was mistaken about my previous decision. I was welcomed warmly and thrust back into a cage, which was more confining than the military "bluejacket" I had just left.

I decided to seek employment in a more technological area, possibly chemistry. I ruled out the medical laboratory because my association with other medical technicians while in the service, painted a very dark picture as far as advancement was concerned.

The beginning of my new career was found three years ago in a newspaper want-ad advertising for high school diploma holders who had had chemistry. The agency sponsoring the ad arranged for an interview and I was sent to Velsicol Chemical Corporation where I am now employed. I was interviewed by many people, all of whom were professionals and by the Director of Research himself. They outlined what a technician's duties were and when the offer of a job was made, I accepted it.

It was two days later that I met Richard Turner. It was he who taught me the basic and standard testing techniques used in the polymer industry -- from softening points, to material balance sheets of raw material evaluations.

In the beginning I worked primarily in the polymer screening area, performing tests which are accepted as industry-wide controls. These tests, to name a few, consisted of Gardner Color and Viscosity, ball and ring softening point determination, cloud points, oxygen absorption, iodine numbers, heat and light stabilities and the compatibility characteristics with other polymers used in formulations. These were repetitive tests which, when learned and a technique developed, required very little independent thinking.

I consider myself very lucky, in that, the Division I work in used this area as a training and proving ground for their new technicians. I know of other technicians in this field who have had their imagination locked up and their motivation stifled from the boredom inflicted by this type of control work over long periods of time.

I was then introduced to the Gel Permeation Chromatograph and the field of the instrumental analysis of polymers. I was sent to Boston where the manufacturer of this intrument held a three day course teaching not only the technique of operating the instrument, but also the basic theory of how and why the instrument functions, as well as the value and interpretation of the data it produced.

It was in this capacity that I recognized what is really expected of a technician and his role in the technological picture. I realized that as a technician I was really an extension of my supervising professional, and that my motivation for learning and understanding this new concept was due to his interest and consideration in explaining in greater detail the meaning of the data and its verification by other methods of analysis.

Other programs in the Division stimulated new desires to diversify my skills. Consultants, men with highly specialized knowledge, addressed our entire group -- professionals and technicians alike. From these meetings came greater insights into the manner which our present and future polymers could be synthesized and tested.

From there I was introduced to the other highly sophisticated analytical and characterization instruments; namely the Infra-red and NMR. Although these instruments are not usually used for control testing, there are some applications in which these instruments can be used with both increased efficiency and accuracy.

Under the supervision of a specialized professional, new techniques were developed -- for example, a technique of measuring the amount of diluent present in a finished product by the adaptation of Beer's Law to the appropriate spectral bands.

At first, this too was comparable to the control section in that it was merely operating the instrument and deriving a number. Slowly, new ideas were presented, books were recommended for further reading and with the permission of the Director, a short course in applied infra-red spectroscopy was given by the professional.

The course consisted of illustrating the different techniques used in infra-red work. The course brought out a basic understanding of molecular structures and a familiarization of where infra-red absorption bands would occur if certain groups were present. Eighty percent (80%) of the work was left to us, in that we learned by reading and practicing our new techniques on standard materials. At the same time, the door to the professional's office was never closed, nor was any question left unanswered, if an answer could be given.

Next, I was instructed in a method of obtaining the number average molecular weight by the use of a vapor phase osmometer. I am now currently learning the techniques of thermal gravimetric analysis and differential scanning colorimetry, for ascertaining the thermal properties of polymers.

This is where I am at the present time, barely scratching the surface in the realm of chemical technology. I supplied the effort and time to get this far, but the motivation and guidance of that effort, which are really the keystones of any career, were supplied by patient and understanding professional people.

If someone seeking a career in chemical technology as a technician were to ask me if this field were rewarding and satisfying, I would give him an emphatic "yes".

I would first point out all the possible areas which will be open to him. I would compare it to a football team, where he is a rookie halfback. Once he can show that he can handle the ball, he will have many opportunities to carry it. He must be perceptive to follow the calls of the quarterback, and the holes that are opened for him by the line. There is no way he can sneak around the end, because in this game there is no substitute for knowledge. If he does try, he could be dropped in the backfield before the play really starts rolling. Persistance and second effort will be his most valuable assets, and with them he can reach the farthest goal.

If this young man should ask me where might he obtain information and/or courses of instruction for chemical industrial work, I would recommend him to either his high school or college counselor (if he is still attending school) and ask the counselor to set a pattern of courses designed to familiarize him with general chemistry. I would be unable to direct him to any type of technological job training school, here in this area, for there are none that I know. (The Southeast Campus of Chicago City College does offer a Chemical Technology Program. Ed.)

Unlike the trade unions or the auto industry, there are no established institutes in the Chicago area which offer the advanced technological training technicians need for performance, and desire for understanding. The on-the-job training programs established in individual companies are often slow and erratic in that these programs are geared to the needs of the employer.

The technician is more directly concerned with the performance of certain accepted techniques, and deriving and reporting a result. Unfortunately, the courses of instruction presently offered in colleges deal mainly with the theory of why they are supposed to work rather than presenting the actual techniques and their applications as used in industry.

More often than not, the technician in industry is usually performing techniques not usually taught at the lower college level, such as the training I received in infra-red, NMR and VPC. Without certain college prerequisites he cannot obtain the advanced instruction which would be more meaningful in the application of his work. It should be recognized too that unlike myself, all technicians are not degree seekers, either by design or by their inability to participate in formal educational programs.

If the chemical technician does undertake these basic courses, the methods and techniques he really wants to learn are merely indicated and passed over, with a promise of learning them at some later time.

The Chicago Section of the ACS has taken some steps to help change this situation by creating an affiliate topical group for technicians and offering to the technician some insights into the work he may be performing. A shortcoming of this program, however, is the lack of communication with the technicians. Bulletin board notices are hardly a way for arousing interest. Perhaps a more personal approach is needed. Maybe the professional chemists, most of whom are members of the ACS, could be persuaded to more actively pass the word to their technicians.

The information of what this group is doing could be better publicized in my own company, but in speaking with technicians from other companies, I found they were not even made aware of the formation of this group.

I have tried here to illustrate two needs of the technician.

1. Greater interest on the part of the employer to expose the technician to the many facets of the overall technology involved, so that he, the technician, can gain a greater background, which would be more interesting and satisfying to him, and make him, in turn, more valuable to the overall effort of the laboratory.

2. The need for establishing technological institutes capable of instructing the technician in various specialized areas with an emphasis on how techniques can be developed and how they are applied in the industry.

CRITIQUE

M. F. Dubravcic
University of Akron
Akron, Ohio

The speaker, Mr. Serauskas, has presented a very interesting and vividly described personal history -- the history of a successful chemical technician who has grown to his own satisfaction and to that of his employer. After hearing his presentation, one is immediately tempted to ask: why was this man advancing in his occupation and what were the factors which determined his success? While a positive answer to these questions is not easy, it is nevertheless possible to single out several contributing factors. I believe that these could be summarized under three headings: personal characteristics, education and the opportunities in the company which he joined.

The speaker's inclination to science, his desire and ability to absorb knowledge, his intelligence and motivation and, no doubt, his attitude toward work and people were probably the most useful personal characteristics.

Apparently, one of the most critical decisions in Mr. Serauskas' career was that of taking advantage of the U.S. Navy supported training program. There he obtained a systematic education in chemistry and some related sciences, plus his first occupational experience. Had it not been for this training, it is doubtful whether, upon his release from the Service, the speaker would have entered a technological field; and, if he did he would have probably never reached his present status.

The company, evidently, deserves the credit for having permitted a qualified and capable young man to grow. My impression is, however, that the general conditions in which the speaker found himself were rather demanding and competitive. Without his previous training and a strong motivation, he may have finished as one of many of those so called "chemical technicians," who are doing boring routine work in control laboratories with little hope for advancement.

In general, it appears that within-the-company technician training programs must be limited by economic necessity in most cases to short courses in specific areas of immediate company interest. The need, however, for hiring qualified chemical technicians has been emphasized on many occasions. I believe the industry would welcome a larger number of these than are presently graduating from our two-year colleges. What can be done to make the career of a chemical technician more attractive to young people? I would appreciate comments on this point by industry representatives present at this conference.

I would also like to see some statistics, or a competent estimate, on the levels of formal education of those persons presently functioning as "chemical technician"; in other words, a description and definition of a typical "chemical technician" presently employed in industry. If this proves to be a high school graduate with limited on-the-job technological training, we would have a better idea about planning his education and determining the courses to offer either by correspondence or through the evening classes.

Finally, it is almost axiomatic that we seek better coordinated efforts for the direct recruitment of high school graduates to our chemical technology programs. While the methods of recruiting also may deserve some attention, I believe that the main problem is in a certain discord of chemistry programs. In high school chemistry, attention has been focussed on theory with the expectation that students will be seeking higher professional degrees. It seems that this approach is not well accepted by the majority of students who may be more interested in various aspects of applied chemistry. Perhaps, a more practical and experimental approach would be of benefit to all students taking chemistry in high schools, including those who may become chemical technicians. Now, after the Technician Curriculum Committee of the ACS has outlined the technician training curriculum, it may be desirable to examine the adequacy of high school chemistry programs as a preliminary to training in chemical technology.

THE TECHNICIAN IN PRODUCTION

Richard R. Shreve
Corn Products Company, Argo, Illinois
and
Waubonsee Community College, Aurora, Illinois

It is a real pleasure to address this fine gathering and to be part of this interesting program.

Papers have preceded me on the chemical technician's function in Research and Development and Quality Control. I shall overlap just a bit on their talks to provide some continuity.

The chemical technician has been engaged in Research and Development and Quality Control for a longer period of time than technicians in production. The higher level of technology and increasing instrumentation has now stirred interest in the technician level in production. This is not to say that chemical technicians have been overwhelmingly accepted in manufacturing. For the same problems that beset the concepts of trained technicians in Research and Development and Quality Control are also present in production processes; a lack of trained personnel, and ignorance of manufacturing supervisors and/or personnel people have retarded the acceptance of chemical technicians in production.

Table 1 (p.) shows the areas of oportunity for chemical technicians. The earlier papers have covered the first two classes quite well. The third and fourth type are probably better known as chemical engineering technicians or engineering chemistry technicians. Our conterpart organization, The American Institute of Chemical Engineers has recently shown increasing interest in this subject. My remarks are confined to the third type, as shown in Table 1, which is the technician engaged primarily in production of raw materials. The last type is engaged in the production of finished or semi-finished products. This includes areas such as paint, plastic extrusion, textile manufacture, etc. There is some evidence to say that classes 3 and 4 of Table 1 should have a slightly different curriculum or option than the first two types. I will have more to say about this shortly.

Coming back to the technician engaged in material production -- a good example would be my employer, Corn Products Company. Here, corn, milo, etc., are converted into raw materials for other industries. In a company such as ours, there is some variety in actual production of materials. Table 2 (p.) shows the basic operations of production. The technician in the plant is under pressure to put the company's technology into practice. This demands an understanding of the total production effort; including transportation, inventory control, product specifications, etc. In production, the process is usually set and the emphasis becomes economic -- i.e., the number of pounds at minimum cost. Semi-works operation stradle the middle between plant production and pilot plant. A run in semi-works varies from 2-3 days to several months. While the emphasis remains economic, it is a different type of economics. Usually there is no long repetitive number of runs but rather the short in-and-out type. Plant technicians have to be alert to spot unusual observations in a minimum number of runs. This obviously has a large effect when a production or process moves into plant production.

Table 1

JOB AREAS FOR CHEMICAL TECHNICIANS

1. EXPERIMENTAL LABORATORY
2. SEMI AND/OR ROUTINE LABORATORY
3. MATERIAL PRODUCTION MANUFACTURING PROCESSES

Table 2

OPERATIONS IN MATERIAL PRODUCTION

1. PLANT PRODUCTION
2. SEMI-WORKS
3. PILOT PLANT

The pilot plant chemical technician has the most rapidly changing schedule of these three areas. Instrumentation, varying equipment configuration, new types of reactions and/or processes, and usually a lot of unknown variables all are characteristic of pilot plant operations. Since the pilot plant represents the first step in scaling-up production of a product, it is important to gain as much understanding as possible. The better technicians in pilot plants have usually had production and/or semi-works experience. In fact, the pilot plant technician usually represents the cream of the crop.

In these three areas -- plant production, semi-works and pilot plant -- there are a variety of positions to be filled by the technician. Table 3 shows some of these positions.

I should point out that instrument related positions will become more important as time goes on since instrumentation is the most dynamic force in the changing methods of production.

One additional position I might add is draftsmen and detail men in the plant itself. All large plants have two or three of these people who do a variety of tasks -- from drawing changes in piping to lettering safety signs.

One can then ask about the abilities and peripheral knowledge needed in the production-oriented chemical technician. I use the expression "ability" to indicate areas where the technician should have some depth of understanding. Table 4 indicates some of the abilities a production technician should have in depth. This is not a complete list but does indicate areas where understanding in depth is needed.

Table 3

POTENTIAL JOB POSITIONS FOR CHEMICAL TECHNICIANS IN MATERIAL PRODUCTION

1. OPERATOR
2. INSTRUMENT REPAIRMAN
3. INSTRUMENT SUPERVISOR
4. SHIFT LEADER
5. ASSISTANT FOREMAN
6. FOREMAN
7. PLANT MANAGER ASSISTANT

Table 4

ABILITIES NEEDED IN A CHEMICAL TECHNICIAN

1. BASIC CHEMISTRY
2. BASIC MATHEMATICS
3. ACCOUNTING
4. INSTRUMENTATION (INCLUDING REPAIR)
5. WRITING AND DATA REPORTING
6. TRANSLATION OF BLUEPRINTS

There are other areas where understanding is needed. Table 5 shows areas where the technician should know something but not necessarily in depth. These topics lend themselves to survey courses. However, knowledge in these areas greatly improves the performance of the individual. In fact, many graduate engineers and chemists need to know much more in these areas.

One of the best founded questions is "how can a school accomplish the training needed to produce the well-rounded chemical technician?" My remaining remarks will be confined to this major problem.

Table 6 shows sources of faculties which are somewhat different than the classical chemistry department. All personnel should have some industrial experience but also need a continuing contact with industry.

Table 5

UNDERSTANDING NEEDED BY A
CHEMICAL TECHNICIAN

1. UNIT OPERATIONS INCLUDING MIXING AND POWER REQUIREMENTS
2. LABOR RELATIONS
3. ECONOMICS
4. ELECTRONICS
5. TRANSPORTATION
6. SAFETY

Table 6

SOURCES OF CHEMICAL TECHNOLOGY
FACULTIES

1. CHEMISTS
2. CHEMICAL ENGINEERS
3. PRODUCTION MAJORS
4. INDUSTRIAL ENGINEERS

Another instructional method that bears consideration is a co-op program of education and work experience. All of the advantages of co-ops are available, such as more contact with industry by faculty, evaluation of personnel by industrial supervisors, and a direct industry interest in your program. This also allows the student to acquire money while going to school, something that has a great bearing on education.

Close contact and cooperation with machinery manufacturers is another method. As technology changes, the faculty should be changing inputs to the students. On the other hand, out-dated machinery can also be useful in training students.

Summer employment is another method for improving the new chemical technician. However, this is somewhat difficult to obtain unless close cooperation is maintained with local companies. It is really more important for the student to obtain the education rather than obtain summer employment applicable to the education.

Salaries are excellent for well-trained chemical technicians in production and manufacturing processes. After 5-7 years, a level of $10-13 thousand is not uncommon. The salary is never guaranteed, but rather depends on the ability of the individual to use his training for his employer. For this reason, continuing education will be necessary throughout his career.

It has been my pleasure to present these topics. I hope to be able to discuss any of the details with you at a later date.

CRITIQUE

Mr. Roger G. Garst
The Chicago City College, Southeast Campus
Chicago, Illinois

Though now a teacher, my industrial experience required supervision on pilot plant operators. My experience confirmed the desirability of the skills mentioned by Mr. Shreve. One facet of their work needs emphasis and colors my feeling on their education. They frequently had a responsibility greater than that of my laboratory technicians, and often found it necessary to work alone and at night.

My pilot plant continuously used hydrogen, a violently flammable gas, at conditions up to 400°C and 100 atmospheres. There were many precautions, including more than a foot of concrete protecting the operators and neighboring equipment. There were also occasions when valves and gauges malfunctioned or fittings leaked. Help was usually precious minutes away during the night. Conditions often had to be changed during the night due to the cumbersomeness and cost of the plant.

The operators kept logs, like ship captains. They read blueprints and my long directions. A speech impediment hindered one. The most valued operator had learned to fix instruments himself. Most importantly, all faced responsibility well. They not only followed safe procedures, but also decided quickly when to stop the plant despite expense and when to contact me.

Each of my operators had more than four years of experience. They had started as laborers, enjoyed some in-plant education, and been promoted partly due to passing a written test.

I doubt that any school could certify its graduates as having a responsibility comparable to that of my operators without the specific familiarity that only months of apprenticeship can bring. Neither could management delegate such responsibility without testing during an apprenticeship. The years of apprenticeship given my operators enhanced safety consciousness and safety was the prime need.

I believe the responsibility borne by my pilot plant operators was not unusual. Pilot plants involve different orders of speed and quantity than do laboratory reactions.

Production foremen, too, have heavy responsibilities and the need for developing rapport which may dictate apprenticeship and selection of where they can work most effectively.

Due to demands different from those imposed on ordinary laboratory technicians, you may be persuaded that a year or two of apprenticeship is desirable before these kinds of jobs are assumed. If so, you must consider the impact on the educational program. If academic education should occupy half or less of the time for training, it would best occur during the apprenticeship. Part-time or cooperative education programs would ease financial strains for most students and might have important psychological advantages.

INTEGRATING CHEMICAL TECHNOLOGY
WITH STANDARD CHEMISTRY COURSES

Norman G. Peterson
Ferris State College
Big Rapids, Michigan

When Mr. Chapman asked me to speak to this group, I was not only delighted, but I knew exactly what to say. As the days moved forward I became less sure of just what to talk about during my presentation. Among the things which I did in order to ready myself was to write a letter to some of my former students and ask for their help. I received a few answers, and those answers will assist me in presenting this paper.

The enrollment in our curriculum at Ferris State College is low, and I hope that as more schools enter into this type of program our enrollment will grow.

I firmly believe that chemical technicians are not only useful, but that they are necessary to the continued progress of R&D, TS&D, QC, and wherever persons work at the chemistry bench. My ideas concerning their necessity have been developed thru the training of technicians, seeing our graduates progress when on the job, as well as not having good academically trained technicians to assist me when I was an industrial bench chemist.

I also believe that there is a severe lag in the production of technicians. I believe that this lack of production on the part of our schools will not greatly improve until industry does something to encourage more persons to receive this training, and to encourage parents that the life of a chemical technician is very rewarding. There are hints in this direction, but not enough. From the requests which we have for chemical technicians from the 25 or more companies that annually come to our campus on recruiting visits, it looks as if a flood of trained technicians is in order.

The program in chemical technology at Ferris State College employs an approach to its chemistry requirements that integrates the chemical technology student into standard chemistry courses. Our curriculum is known as Industrial Chemistry Technology (ICT). This paper is a focus upon one school's approach to the academic training of chemical technicians. In order that one might visualize how this program operates, it is first necessary to know something about the operation of Ferris State College.

The administrative structure at Ferris State College has been developed to contain five schools and one division. These are the schools of Business, General and Pre-professional Education, Health Sciences and Arts, Pharmacy, Technical and Applied Arts, and the division of Teacher Education. Each of these schools offers a wide choice of curricula for the student. A student may enter a program of High School completion, Certificate of completion in a college or trade related program, Associate in Applied Science degree, and Bachelor of Science degrees are also available.

Faculty within our schools teach a speciality, and those persons within a certain curriculum area normally teach within their own curriculum. Our School of General Education is perhaps the hub of the wheel, as that school acts as a service to all of the other schools. We do find many students enrolled in this school in a pre-professional curriculum. In this latter sense, this school acts as a Junior College, or the first two years of a four year instituion. Normally this school does not offer third or fourth year courses, except as it is necessary to service the students in another school.

As a result of this type of organization, we find that the students enrolled in our ICT curriculum receive most of their chemistry from a faculty member in the department of Physcial Science within the School of General Education.

Let us consider the ICT curriculum at Ferris State College and its method of operation. The administration of the students in the ICT curriculum comes under the school of Technical and Applied Arts; yet, all of the courses except those which are specifically called Industrial Chemistry are taken within the school of General Education. All students in the ICT curriculum have as their advisor someone in the ICT curriculum. It is the advisor's responsibility to follow the academic progress and assist each student in his academic life.

In any two year program which by its design may be terminal, the student requires assistance from someone to whom he feels close. Since there is but little time for error in judgement in scheduling, a faculty member has close watch over the student's schedule.

Our ICT student receives the majority of his chemistry education from the faculty in our school of General Education. These are relatively standard first and second year college chemistry courses. It is here that our students study chemistry along with pharmacy students, pre-engineering, teaching majors and others. In this area, a student may or may not have a continuity of instructors. We have about twelve persons teaching chemistry within the School of General Education.

In addition to the classical chemistry courses, there is an added emphasis which we have called Industrial Chemistry. This added emphasis is necessary in order that our students will have the usefulness required by industry of a chemical technician. I am sure that courses other than ours will also fill these requirements. These industial courses are taught within our school of Technical and Applied Arts, and have been designed by our staff and advisory committee to do a job of teaching so that upon graduation our student will possess job competence.

I do not feel that the purpose of the special courses in Industrial Chemistry is to add tremendously to the storehouse of theoretical knowledge held by the student, but it must take him by the hand and show him what is likely to be found when he works in industry. After he is shown what may be found, we must then capture his imagination by creating a situation whereby he really wants to know something.

Two thirds of the ICT curriculum in the area of chemistry might be described as "classical" chemistry as taught within our school of General Education. The other third falls within our area of attempting to make a more marketable product possessing job competence. Oh, I suppose that our students should have skills if they did not take our ICT courses, but we believe that their warehouse of skills is far greater as a result. We also believe that their future will be brighter for having taken our ICT courses.

Appended to this paper is the ICT curriculum as taught at Ferris State College.

To create our ICT curriculum was not difficult. We had most of the offerings already on our campus. When the need was pinpointed, it was a matter of obtaining an instructor, creating a few new courses and we were in business. The ICT curriculum at Ferris State College has been operational since 1957.

Most of the students who finish our curriculum tend to rank in the upper 25th percentile as measured by general academic ability tests. I see no reason why many persons of lower general academic ability could not do highly skilled work as chemical technicians.

In answer to my letter from former students, they seem to be almost 100% in favor of classical chemistry courses plus some specialized courses pointed toward job skills. That is, just as they had it at Ferris State College. Perhaps they favor that system as the system they knew, or perhaps, as several have indicated, they needed standard chemistry courses so that those courses might be transferable toward a B.S.

I have appreciated sharing these thoughts with this group, and I hope to be involved with the training of chemical technicians for a long time to come.

INDUSTRIAL CHEMISTRY TECHNOLOGY AT FERRIS STATE COLLEGE

Degree Requirements	Term Hours Credit
Political Science	6
Social Science	6
Humanities	3
Electives	3
Health and Physical Education	3
College Orientation	1
Chemistry from the School of General Education	
General Chemistry	10
Qualitative Analysis	6
Quantitative Analysis	5
Organic Chemistry	15
Industrial Chemistry Courses	
Orientation to Industrial Chemistry	2
The Chemical Laboratory	2
Industrial Applications of Chemistry	3
Instrumental Methods of Analysis	4
Industrial Methods of Analysis	3
Chemical Manufacturing	2
Chemical Technology Calculations	2
Related Professional	
Mathematics	7
Physics	8
English	9
TOTAL	100

CRITIQUE

J. Fred Wilkes
Dearborn Chemical Co.
Chicago, Illinois

I agree most heartily with Mr. Peterson that chemical technicians not only are useful, but essential to the chemical industry. Not only are they vital members of the R/D team, but also are equally important in control, analytical, technical service, and production operations. One of the objectives of ACS activities on behalf of the chemical and chemical engineering technicians is to help them gain pride in their profession, seize available opportunities for self-improvement and growth in technical knowledge; but even more important, to make employers better aware of the ability and potential contributions of technicians to the overall effort.

Why are technicians so effective in analytical and control assignments? Maybe because they follow procedures exactly! All of us have worked with BS chemists and even more experienced scientists, who think they know more than the experts who designed the analytical and control procedures, and who short-cut, or omit essential steps. And what about the highly skilled graduates (even Ph.D.'s), who are experienced in operation and interpretation of the most exotic instrumental procedures, but lack the simple skills needed to adjust the standard solutions needed for calibration? Most BS chemistry curricula no longer include standard quantitative and qualitative analysis courses - relying more and more on theoretical and instrumental approaches.

The reasons cited by Peterson for lag in production of chemical technicians are valid, and important. But the finger of responsibility must be pointed not only at industry. Those of us interested in scientific and educational society activities, and in career guidance, also must do our part. We see the stimulation of interest in basic science curricula among high school (and younger) students as a major responsibility of the American Chemical Society, its local sections, and its individual members. The challenges and rewards from science careers are just as real as those of the humanities. How much better can one contribute to the good of humanity, than by using his scientific training for alleviation of problems of disease, mental health, food and nutrituional deficiences, over-population, and creation of jobs for the underprivileged?

Peterson has recommended that only those with some degree of industrial experience should become involved in training of chemical technicians. I agree fully with this viewpoint, which may well be disputed by those in academia. But it applies equally well to chemistry professors teaching BS and Ph.D. candidates! It was a major conclusion of ACS OPERATION INTERFACE 1967 that there should be mutual interchange between academia and industry. Sabbaticals for qualified industrial chemists, to be spent in refresher training on a campus where they could assist in laboratory courses, conduct seminars and other sessions, would let them pass along the industrial viewpoint to some extent. They could also provide actual industrial process examples as the basis for theoretical studies. Professors with no industrial experience or industrial consulting contracts find it difficult to impart the processes in which theory is applied by industry, to achieve useful results.

The idea of sabbatical applies equally well in the reverse sense. Instead of spending these leaves on another campus, the professor could benefit greatly from a year spent with industry, where many challenges in high-level research, development and basic research await. Opportunities for summer work in industry should be made available to chemistry faculties of Liberal Arts colleges, which often provide salaries for only 9 or 10 months/year, have no research grants to provide summer compensation, or are located where consulting opportunities do not exist. In short-term assignments with industry, these professors could make real contributions in productive research, methods development and continuing education -- while gaining a 'feel' for what industry is like.

I like very much the close personal contact between students and faculty which is provided as part of the ICT curriculum. This cannot exist in most 'classical' chemical courses which are overcrowded and impersonal. In the latter, the students get 'talked at', but have limited opportunity to participate, or get the benefit of frequent contacts with faculty advisors. Job competence training as well as theoretical skills are offered in balanced proportion in this curriculum, a strong advantage. I concur that a strong effort must be made to capture the imaginations of the students, and to instill motivation.

Peterson says that chemical technology instructors must have a different outlook than those concerned with teaching and supervising research of Ph.D. candidates. For chemical technology training, the instructors must have some industrial background. I can see particular value in those professors who had to struggle to learn their specialties -- vs. those brilliant, but mercurial individuals who may be stimulating, or controversial, but who tend to skim the surface of subjects, rather than impart 'in-depth' insight.

Very often the Freshman level general courses do serve as 'flunk out' courses (as Anatomy does for Pre-Med), and the teaching is relegated to junior faculty -- rather than to the most competent and challenging individuals. This is unfortunate, and only increases the rate of drop-out from basic sciences. Clearly, an emphasis change is needed in this most-difficult course.

I was surprised that Peterson's former students see a need for more emphasis on 'classical' courses, as well as those pointed toward development of job skills. Perhaps this reflects the character of the teacher, who has succeded in imparting a desire for more knowledge, and self-improvement, in the minds of those lucky enough to be exposed to his influence.

At all levels there is a constant need for self improvement, to combat the tremendous rate of scientific advance. The ACS has recognized this need, and is making real contributions by providing numerous tools which facilitate continuing education.

THE CHEMICAL TECHNOLOGY PROGRAM AT LORAIN COUNTY COMMUNITY COLLEGE

C. E. Hoffhine
Lorain County Community College
Elyria, Ohio

The origin of this program goes back to the passage of the National Defense Education Act of 1958. In 1959, an industrial advisory committee was formed to survey the Lorain County area industries to determine the most pressing needs for technicians. This survey showed an annual repeating need for Chemical, Mechanical and Electrical technicians to work mainly in research and development positions.

Specialized industrial advisory committees were formed to recommend choices of curriculum, equipment, texts, etc. In 1960, the Lorain City Board of Education made space available for classes and laboratories to meet. Fifty students enrolled in the initial phases of the school called Lorain School of Technology. The first graduating class was June, 1962. There was good success in placing graduates in industrial jobs.

The course content in Chemical Technology is college level; however, there is a balance of theory and practice and the primary objective is industrial employment - not college transfer to a four-year college.

In 1964, Lorain School of Technology became a part of the new Lorain County Community College which offers study in fourteen career curriculums plus the first two years of college for study transfer purposes. Approximately 2,200 full-time day students are now enrolled in all of the above fields of study.

The outline of the Lorain County Community College's Chemical Technology program follows.

LORAIN COUNTY COMMUNITY COLLEGE
Elyria, Ohio

Chemical Technology

	FIRST YEAR	Class Hours	Lab Hours	Credit Hours
First Quarter				
General Chemistry	C. T. 111	3	4	4
Organic Chemistry	C. T. 121	3	3	4
Basic Concepts	Economics 211	3	0	3
Communication Skills	Eng. 111	3	0	3
Chemical Calculations	Math. 116	5	0	5
		17	7	19
Second Quarter				
General Chemistry	C. T. 112	3	4	4
Organic Chemistry	C. T. 122	3	3	4
D. C. Theory	E. E. T. 111	3	3	4
Communication Skills	Eng. 112	3	0	3
Chemical Calculations	Math. 117	3	0	3
		15	10	18

Chemical Technology

FIRST YEAR
(Cont.)

Third Quarter		Class Hours	Lab Hours	Credit Hours
Qualitative Analysis	C. T. 113	3	4	4
Organic Chemistry	C. T. 123	3	3	4
Technical Communication Skills	Eng. 115	3	0	3
Chemical Calculations	Math. 118	3	0	3
Metallurgy	M. E. T. 111	2	3	3
Physical Education		0	2	1
		14	12	18

SECOND YEAR

First Quarter		Class Hours	Lab Hours	Credit Hours
Quantitative Chemistry	C. T. 211	3	4	5
Industrial Analysis	C. T. 214	2	4	3
Polymer Chemistry	C. T. 224	3	0	3
Instrumental Methods	C. T. 241	1	6	4
Basic Concepts Soc.	Sociology 211	3	0	3
		12	14	18

Second Quarter		Class Hours	Lab Hours	Credit Hours
Quantitative Chemistry	C. T. 212	3	4	5
Electro Chemistry	C. T. 231	2	4	4
Instrumental Methods	C. T. 242	1	6	4
Basic Concepts	Psychology 211	3	0	3
Physical Education		0	2	1
		9	16	17

Third Quarter		Class Hours	Lab Hours	Credit Hours
Quantitative Chemistry	C. T. 213	3	4	5
Electro Chemistry	C. T. 232	2	4	4
Instrumental Methods	C. T. 243	1	6	4
Management and Supervision	I. E. T. 228	3	0	3
Physical Education		0	2	1
		9	16	17

COURSE DESCRIPTIONS -- CHEMICAL TECHNOLOGY

Chemical Technology 111 — 4 (7)

General Chemistry. Study of chemical theory and structure. The concepts of elements, symbols, atomic number, compounds and molecules in terms of atomic structure. Study of the common elements (oxygen, hydrogen, etc.) to illustrate reactions and properties and their relation to reactions and equations. Laboratory fee: $7.

Chemical Technology 112 4 (7)

General Chemistry. Study of reactivity of elements and compounds to illustrate chemical properties and transformation, including elements such as chlorine, nitrogen, carbon, phosphorous and their compounds. Prerequisite: C.T. 111. Laboratory Fee: $7.

Chemical Technology 113 4 (7)

Qualitative Analysis. Mainly concerned with qualitative analysis (cations and anions) and the chemistry and properties of metals and their compounds. Concepts of solubility, equilibrium and pH, etc. Prerequisite: C.T. 112. Laboratory fee: $7.

Chemical Technology 121 4 (6)

Organic Chemistry. Introduction to organic names and structures for compounds of carbon, hydrogen, etc. Reactions and properties of hydrocarbons, alkyl halides, alcohols, ethers, etc. Prerequisite: C.T. 111, or concurrently. Laboratory fee: $10.

Chemical Technology 122 4 (6)

Organic Chemistry. Continuation of the study of organic names, formulas, reactions and properties. Aldehydes, ketones, organic acids, salts, esters, amines and amides. Prerequisite: C.T. 121. Laboratory Fee: $10.

Chemical Technology 123 4 (6)

Organic Chemistry. Study of compounds such as sugars, carbohydrates, benzene and derivatives, heterocyclics, amino acids and proteins. Prerequisite: C.T. 122. Laboratory Fee: $10.

Chemical Technology 211 5 (7)

Quantitative Analysis. Correlation of the analytical chemistry in actual use today with applicable principles and calculations concerning the treatment of analytical data and acid-base equilibria. Prerequisites: C.T. 113 and Math. 118. Laboratory Fee: $5.

Chemical Technology 212 5 (7)

Quantitative Analysis. Correlation of analytical chemistry in actual use today with applicable principles and calculations concerning oxidation-reduction equilibria, single electrode potential, galvanic cells and standard potentials. Prerequisite: C.T. 211. Laboratory Fee: $5.

Chemical Technology 213 5 (7)

Quantitative Analysis. Correlation of analytical chemistry in actual use today with applicable principles and calculations concerning precipitation titrations and complex formation titrations. Prerequisite: C.T. 212. Laboratory Fee: $5.

Chemical Technology 214

3 (6)

Industrial Analysis. Exposure of students to common denominator of analysis from representative industries. Prerequisite: C.T. 211, or concurrently. Laboratory Fee: $5.

Chemical Technology 224

3 (3)

Polymer Chemistry. Study of high molecular weight polymers and plastics such as polyvinyl, polyethylene, polystyrene, polyesters, polyamides, etc., including reactions, structures and properties. Prerequisite: C.T. 123.

Chemical Technology 231

4 (6)

Electro-Chemistry. Experiments based on the functional use of principles and processes of electro-chemistry as stressed by area industries. Fundamental techniques and applicable theory concerning anodic and cathodic current efficiency. Effect of concentration changes and deposition from solutions containing several cations. Prerequisite: C.T. 211. Laboratory Fee: $5.

Chemical Technology 232

4 (6)

Electro-Chemistry. Experiments based on the functional use of principles and processes of electro-chemistry as stressed by area industries. Fundamental techniques and applicable theory concerning hydrogen overvoltage, concentration polarization, limiting current density and the nature of the electrolyte. Prerequisite: C.T. 231. Laboratory Fee: $5.

Chemical Technology 241

4 (7)

Instrumental Methods. Survey of the basic principles, characteristics and limitations of those instruments with important applications in chemical laboratories of representative industries. Work experiences with each instrument based on practical example. Solvent extraction, refractive index, vapor pressure, and viscosimetry. Prerequisite: C.T. 123; and C.T. 211, or concurrently. Laboratory Fee: $5.

Chemical Technology 242

4 (7)

Instrumental Methods. Work experiences with each instrument based on practical examples. Surface and interfacial tension, polarimeters, electrophotometers and spectrophotometers. Prerequisite: C.T. 241. Laboratory Fee: $5.

Chemical Technology 243

4 (7)

Instrumental Methods. Work experiences with each instrument based on practical examples. Chromatography, ion exchange, duo-spectranal and chloridiometer. Prerequisite: C.T. 242. Laboratory Fee: $5.

COURSE DESCRIPTIONS -- COMMUNICATION SKILLS

English 111 (3)

Communication Skills I. A study of the nature and effective application of English as a basis for effective communications. Specific assignments made with emphasis on interpretive reading and clear, concise writing.

English 112 3 (3)

Communication Skills II. Continuation of English 111 with added emphasis on clear, concise speech and interpretive listening. Prerequisite: English 111.

English 115 3 (3)

Technical Communication Skills. Continuation of English 111 and 112 with special attention to and adaptation of these skills to meet the needs of technical and nursing students in scientific and engineering programs. Problems in reporting techniques and other types of writing such as articles, abstracts, manuals, specifications, summaries, and resumes covered along with methods of collecting data for both written and oral presentation. Prerequisite: English 112.

COURSE DESCRIPTIONS -- MATHEMATICS

First year

Mathematics 116 Meets 5 hr. per week. 5 cr. (Q.)

Chemical Calculations. Practical application of mathematics to chemical problems and concepts. Use of slide rule and logarithms as calculating aids; use of formulas to calculate density, molecular weight, specific gravity, percent composition, etc. Prerequisite: 1 year of High School Algebra, or L.S. 053.

Mathematics 117 Meets 3 hr. per week. 3 cr. (Q.)

Chemical Calculations. Continuation of Math 116. Chemical Concepts of equations applied to calculation of weight to weight; weight to volume; and volume to volume; concepts of weight, volume and moles. Prerequisite: Math. 116.

Mathematics 118 Meets 3 hr. per week. 3 cr. (Q.)

Chemical Calculations. Continuation of Math. 117. Detailed study of concepts of pH, solubility, solubility product, ionic and chemical equilibrium, molar and normal solutions and stoichiometry. Prerequisite: Math.1117.

COURSE DESCRIPTION -- OTHER

Economics 211 3

Basic Concepts of Economics. Basic economic concepts and analysis. Economic factors relating to production, income, consumption, and employment. The rule and influences of prices. Analysis of the central problems of an economic society.

Electrical Engineering Technology 111 4 (6)

D. C. Theory. Electron theory; electrical units; Ohm's and Kirchoff's laws; series, parallel, and complex circuits; network theorems; direct current meters; conductors and insulators; resistors; magnetism; electromagnetic induction; direct current generation. Prerequisite: High School Algebra.

Psychology 211 3 (3)

Basic Con~~cepts. The~~ individual in business and industry, including the study of the individual and why he behaves as he does. Case studies in which the various human factors are defined and analyzed.

Sociology 211 3 (3)

Basic Concepts. Analysis of the fundamental and social concepts in human relations. The significance of culture, status, role socialization, and group behavior to management and supervision. Organization structure, institutional change.

Mechanical Engineering Technology 111 5 hr. per week. 3 cr. (Q.)

Metallurgy. Basics of physical metallurgy, including crystal structure, alloys, equilibrium diagrams, the iron-carbon system, physical properties and tests, and basic metallography. Prerequisite: C.T. 101 or C.T. 111. Laboratory Fee: $5.

Industrial Engineering Technology 228 3 (3)

Management and Supervision. Principles, functions, and coordination of industrial organizations, including fundamentals of leadership, industrial relations, and supervisory techniques.

28 courses + 3 Quarters of Phys. Ed. 31 courses -- complete curriculum.

Comments about Two-Year Chemical Technology Curriculum compared to usual college chemistry courses

1. Chemical Technology courses are taught only by instructors with extensive industrial background and experience -- as well as educational background.

2. Balance between theory and practice of chemistry -- both in class and laboratory.

3. Extensive use of movie films (Brittanica, Bureau of Mines, Various Industries) to put life into curriculum.

4. Emphasis on instrumentation, library research and report writing--especially in the second year of the curriculum.

There are fifteen to twenty students enrolled in each year's work. Typically, twelve to fifteen students are graduated each year. Some students take three years to complete the curriculum because of employment and commuting taking time away from attending classes.

Employers are eager to hire the graduates. Most students are placed in Northeastern Ohio industries, but in the last year or two IBM Xerox, Allied Chemical and others have been coming from New York and New Jersey to interview our students. Typically, we could place three or four times as many graduates as are actually available.

Since 1964, Glidden Laboratories in Cleveland and the Diamond Research Center near Painesville, have been consistent employers of LCCC Chemical Technology graduates. Since then such industries as Sohio Research, Goodrich Research and Firestone Research have been actively seeking to hire our graduates.

The data presented below provides information on 1967 graduates.

GRADUATE PLACEMENT - 1967

No.	Industry	Monthly Salary
2	Goodrich Research	$550 (each)*
2	Xerox	550 (each)
1	Sohio Research	530
1	Glidden Research	565
2	Firestone Research	550 (each)
1	Udylite Corporation	550
1	Diamond Research	550
1	IBM - Chemical Development	525
1	Pittsburgh - Research & Dev. (B.)	570
1 or 2	entered U.S. Air Force - working in Chem. Labs.	

GRADUATE PLACEMENT - 1968

No. Placed	Industry	Monthly Salary**
1	U. S. Steel	$675
1	Union Carbide Research	600 +
1	Clevite Research	600 +
2	Glidden Research	625
2	Diamond Research	625
1	Goodrich Research	575 + overtime
1	Harshaw Development Laboratory	575 + overtime

In general, our graduates have been very successful in their jobs and the industries are eager to hire more of them. As in any human situation, there have been 1 or 2 cases where graduates have changed jobs because of lack of personal adjustment -- not because of lack of knowledge.

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* Fall 1968, all now $600 + per month.

** Several report raises after six months.

The major problem is to induce students to enter the curriculum. Many students in high school avoid the study of mathematics and science. Our entrance requirements are minimal in that high school chemistry is recommended, not required. A serious interest in laboratory work is the most important quality that is sought in choosing students.

More and more industries are depending on chemical technicians for research and development and also for the quality control of complex processes.

Acknowledgements: The aid and encouragement of the following persons has been invaluable in establishing our Chemical Technology Curriculum:

Dr. Max Lerner, President of
Lorain County Community College

Mr. Geo. Sandrew, Assoc. Prof. of Chemical Technology at
Lorain County Community College

Mr. C. E. Stiner, Dean of Science and Technology at
Lorain County Community College

The Advisory Committee from B. F. Goodrich, U. S. Steel and Harshaw Chemical Corp., was responsible for the original curriculum content and selection of equipment.

CRITIQUE

John E. Forrette
Velsicol Chemical Corporation
Chicago, Illinois

The remarks made by Mr. Hoffine were certainly excellent and I am in general agreement with the program which they are conducting at his college. For years I have been of the opinion that programs of this nature can be adequately sustained. And in this day and age, they are becoming a necessity.

There are a few points which I would like to make which are relative to these Separate Programs and I hope they will be food for thought.

First, within the realm of my limited knowledge, it appears that most of these programs are being taught in Community Colleges or Institutes which are either in or in close proximity to major industrial areas. In this respect, they have a ready outlet for graduates and a good source for students. All they need is a good public relations campaign to attract eligible high school graduates.

I would like to consider the cases of the talent we have in the rural areas. Though the population density is more sparse, collectively, there is a wealth of talent available. Many of these young people come to the cities for employment and some drift into the Chemical Industry.

Unfortunately, most of those who come to the cities need to earn money to sustain their livelihood and are unable to attend school on a full-time basis. Others do not care to enter into degree programs or even partial degree programs. However, they would be interested in a chemical technician's program which would give them a practical knowledge within a reasonable time by attending evening school.

An alternate plan would be to bring this type of training nearer to where they live. When one considers that there are many colleges and universities located in the rural areas, it seems logical that this type of program could be strategically located to reach a substantial portion of our young people before they leave home.

The question then arises as to whether a major college away from a big city can sustain such a program. Another question would be, "Can a smaller college embark on such a program with a limited anticipated enrollment?" I would say yes, if they had the assistance of organizations like the American Chemical Society and the State Commissions on Education.

Educating these young people before they come to the cities will help alleviate unemployment and other problems associated with the cities and at the same time answer a need for industry. Industry can also help by cooperating with State Agencies in assisting in placement of these individuals as well as helping to recruit people into these programs.

All of this points to the fact that this must be a cooperative effort among all of us.

THE AMERICAN CHEMICAL SOCIETY ACTIVITIES IN CHEMICAL TECHNOLOGY EDUCATION

Carleton W. Roberts
The Dow Chemical Company
Midland, Michigan

It is a pleasure to be included in this conference on chemical technicians under the sponsorship of the American Chemical Society and Mr. Kenneth Chapman's office.

We have been involved in the area of chemical technician education since the ACS biennial education conference held in 1964 in Washington, It was at this conference that the ACS first took formal cognizance of the existence of the chemical research technician. From the recommendations emanating from the 1964 conference, one committee was appointed by the Board of Directors of the ACS under the chairmanship of Dr. William G. Young. Its charter was to investigate the whole area of chemical technicians, their education, training and other germane items. The Young Committee worked very diligently to "zero-in" on areas with which the Society both could and should be concerned. The recommendations from the Young Committee were basically centered around the training of chemical technicians. Both the formal and informal educational processes were considered.

Two major recommendations areas were presented. The first, Curricula in Chemical Technology and Recommendations to the Board of the ACS, was that we should develop a recommended set of objectives and courses which would be common to all chemical technology curricula nationally and appoint an advisory committee on the training of chemical technicians which should be responsible for keeping the recommended objectives and core courses in line with the changes and the requirements of industry brought about by new technological developments and provide a stimulus for and guidance for the organization and operation of a network of regional or local area committees. A second area was noted; namely, the Society and the Chemical Technicians and a number of recommendations were made.

The recommended two-year curriculum in chemical technology with options which was the result of this first committees' curriculum recommendations are attached. This curriculum was based on certain conclusions which had been reached through extensive surveys by Mr. William Mooney and represented the consensus of the committee at that time. The prerequisites for this curriculum were one year of algebra, one year of plain geometry, and one year of a physical science in high school. (It was thought that students who did not satisfactorily have these prerequisites should complete equivalent pre-technology courses at the college prior to enrollment in the curriculum.) It was concluded that the chemical technology students be included along with chemical transfer students in the theory portions of the chemistry core courses providing that the theory level of such courses does not differ greatly from the level recommended for these courses. That sounds like a lot of weasel words and perhaps they were at the time.

As a result of the Young Committee's efforts, two committees were appointed by the Society. One was the ad hoc Board Committee on Chemical Technician Curriculum and the other was a committee of the Council chaired by Mr. LeRoy Clemence. The Technician Curriculum Committee has been operating since 1966 and we believe that we have pursued with great diligence the charge which came from the original

Young Committee recommendations. You have seen or will see the technician curriculum committee's recommendations for chemistry core courses suitable for training chemical technicians. (Immediately follows this paper.) This looks like a most ambitious curriculum and I believe that if you take the time to read the whole introduction and the recommendations that were printed in Chemical & Engineering News in 1967 that they will make sense. You will see that a major break was made with the Young Committee recommendations (and with most of our own personal attitudes towards continuing or total education) so far as the concept of transfer, and occupational (terminal) curricula are concerned.

This decision was made by us with deliberation. We regretted the necessity of devising, in a natural science, any training program which could be criticized as dead-end. It was not and is not our intention that this curriculum be considered a terminal or dead-end training program, but we found it impossible to construct a training program that is two things at once. We found it impractical to "water-down" a transfer program leading to a Bachelor of Science in Chemistry to the level suitable for the training of chemical technicians. This was largely predicated on experience across the country in the so-called most successful training programs for chemical technicians. In a series of outstanding schools, who purport to have technician training courses and curricula, it was obvious that those schools which had the greatest pride in their technician programs were also those who had the highest percentage of students going on to a four-year school and whose students successfully completed the standard BS in chemistry degree. It appeared to us that the efficacy of the training programs for the chemical technicians was not being judged on the basis of how many excellent technicians were being trained, but rather on the high level of the first two years of training in chemistry. While this is a most worthy endeavor and certainly pleases those of us who have chosen chemistry as a profession and career, this does not solve the basic problem of training the support personnel for the research and development chemists at the sub-baccalaureate degree level.

While I am sure that this is a controversial area, I believe that our committee's conclusions are correct. Our committee has continued to serve and has made a series of subsequent recommendations, one of which is perhaps most cruicial and critical to the total future of the chemical technician and their training programs in this country. This contribution is the generation of a Pilot Program for the preparation of the best possible textual materials for the formal training of chemical research technicians. We have been convinced from the beginning that the various formal curricula which had been presented prior to our committee's formation were either regurgitations of over-simplified classical sub-disciplinary curricula or were watered-down theoretical topic courses quite unsuitable for the training of people who would be, at the start, primarily support personnel with the requirements for an excellent training in laboratory research methods and chemistry. We have found that there are some isolated textbooks which might be and have been used for the formal training of chemical research technicians. Many of the outstanding schools today are using the standard BS in Chemistry curriculum textbooks.

We felt that this is a time of change in all chemistry curricula, representing a golden opportunity to assemble a topical outline and a curriculum which would take advantage of progressive thinking. We believed we should begin, where possible, to remove the arbitrary sub-disciplinary divisions between parts of chemistry and to develop an integrated course. This experiment is well advanced in the four-year programs at several selected schools and excellent curriculum materials are being produced. It seemed to us that it would be highly beneficial were this type of approach to be used at the early stage and at a lower level where the maximum utility of laboratory experience could be directly integrated into the training programs. We do not believe that this means the theory is not taught nor that the modern concepts are not taught. It does mean that every effort will be made to use the integrated approach, hand in hand with viable and relevant laboratory experiments, so that the total training program is one that gives a total product.

Too many of our technicians have come into the ranks either as drop-outs from four-year programs or from BS degree schools having taken a degree in some other area than chemistry. Too many of our technicians today find themselves unable to progress within their companies or within their chosen laboratory careers as a result of this type of hodge-podge training. We feel very hopeful that our pilot program will be successful and that the textual materials which will become available will be suitable for use in the schools and on-the-job training programs. We predict that their availability will attract other first-class two-year schools to initiate technician training programs.

Too often, the teachers in our two-year schools have not had the time, and perhaps the motivation, to provide the textual materials which they would like to have for their own courses and technician curricula. It is our sincere hope that this pilot program will help fill this void and will provide the necessary textual material.

There are many other facets of the ACS-chemical technician interface. As I indicated before, Mr. Clemence has had a very active Council Committee on Technician Affiliation for the last two years. As a result of this Council Committee's efforts we have put on, in various locations, symposia by and for chemical technicians and by the companies and government installations which have permitted their men to make the trip and give the papers based on their own work. At present, the Society already has a mechanism for accepting as affiliates to its Local Sections and to its Divisions chemical technicians who express a desire to affiliate. There are no formal requirements for this affiliation. I personally see the day when we will have requirements to be met for some ill-defined, at the present time, affiliation or affiliate membership in the Society. I am sure that not only do we have a responsibility for the training of chemical technicians and the course content that goes into these programs in a natural science, but also we have an educational and scientific responsibility to acknowledge the existence of these people.

I personally would not like to see us in this country take over the typical European training program for technicians and technologists and make the students choose a career at such an early age and be locked out of progressing in the typical Horatio Alger fashion to bigger and better things. I do think, however, that by having the ACS involved in the total chemical technician picture that we can expect an objectivity of approach in the career treatments of our supportive chemical technicians.

EDUCATION

Chemistry core outlined for technicians

ACS technician curriculum committee recommends chemistry courses it believes suitable for training chemical technicians

The ACS Ad Hoc Technician Curriculum Committee has come up with what it believes is a basic chemistry curriculum suitable for modifying established programs of technician training and for the development of new programs. Appointed by the ACS Board of Directors in 1966 (C&EN, Oct. 3, 1966, page 24), the committee, under the chairmanship of Dr. Carleton Roberts of Dow, has since concentrated on the chemistry core of 28 to 30 units proposed by the earlier Ad Hoc Committee to Study Technician Training. That committee, appointed by the Board in 1964, was chaired by Dr. William G. Young, vice chancellor of the University of California, Los Angeles.

Included in the Young committee report of August 1965 were a suggested 68- to 72-unit, two-year curriculum in chemical technology and a recommendation that another committee be appointed to develop curriculum guidelines. The Roberts committee, composed of representatives of industry and research organizations as well as technician-training and other academic institutions, considered the chemistry core of the proposed two-year curriculum to be in greatest need of attention. At the request of the Board, the Roberts committee will continue functioning to determine whether further recommendations should be made and suggest means by which its recommendations may be implemented. To facilitate its activities the committee desires reaction to its proposed chemistry curriculum, which follows. [Comments on the curriculum should go to Dr. Roberts, members of his committee, or to Kenneth Chapman, who begins work next month in the new ACS staff position (C&EN, Feb. 6, page 62) to administer ACS programs related to various aspects of chemical education in two-year institutions].

Perspective. This basic curriculum for chemical technicians is designed to give a student the knowledge and skills necessary for him to be immediately useful as a chemical technician, upon successfully completing a two-year program resulting in an associate degree. We identify the role of the technician as intermediate between that of a professional chemist and that of a routine operator or laboratory worker. The technician must be skillful in the accumulation of data and their presentation; he must be able to recognize inconsistencies in data; he should have some feeling for the basic statistical significance of experimental results; he must have sufficient understanding of chemistry to appreciate the meaning of his results, but generally, data interpretation will be the responsibility of professional personnel.

Because one of the essential objectives of this curriculum is to educate an individual to make accurate and reliable measurements with understanding, the *laboratory* training is more important than it is in a curriculum leading to a degree in general education or even to more advanced work in chemistry. Thus, both the experiments and the equipment must be capable of providing accurate, quantitative results.

Curriculum. It is presumptuous to spell out the specific content and order of presentation because individual circumstances, such as the background and preparation of the students, the interests and tastes of the instructors, and the physical and geographical environment, may favor or demand concentration in one area or another for optimum use of the students' time and energy. However, it is possible to identify broad areas of chemistry which are appropriate to any curriculum and these are outlined below. Some of these areas are quite obviously more basic to chemical practice and may require more concentration of time or effort than others; the enumeration below does not attempt to define in detail the relative efforts which should be placed on any one area since, again, this effort may be determined more by the background of students and faculty than by presumed significance in the whole chemical program.

The laboratory program is also not spelled out in detail. Rather, we feel the whole program should be based on the notions of synthesis, separation, purification, characterization, and study of physical and chemical properties. Thus, virtually the same technique may be useful in inorganic or organic synthesis and the analy cal techniques may be adapted characterization of compounds pr pared during the program.

As indicated in the perspective, t techniques should be as quantitati as practicable at each level of t curriculum. Such techniques shou be used repetitively throughout all the courses as the needs and opp tunities arise. The student must allowed enough time for the wo (the laboratories should meet at thr hours per credit hour) and wherev possible, the data should be presente graphically and interpreted criticall A basic amount of equipment is esse tial to support such a curriculu Such equipment should include singl pan balances, pH meters and ele tronic colorimeters of different leve of sophistication, and a vapor-pha chromatograph with recorder. Oth suggested equipment includes nucle measuring devices and an infrare spectrometer.

Topical outline of the core curriculu

1. *Basic concepts*

   A. The essential notions of ato and molecules

(1) The nuclear atom; atomic numbers; electrons, protons, neutrons; the properties of particles including mass, charge, and spin
(2) Elements and compounds as collections of atoms and molecules; molecular geometry
(3) Atomic and molecular structure *in brief;* orbitals, bonds
(4) States of matter; gases, liquids, solids; structure of solids
B. The mole concept and stoichiometry
(1) The connection between a molecule and a mole; Avogadro's number; the various meanings of a chemical formula and equations
(2) Atomic, molecular, and formula weights; methods, i.e., mass spectrometry, gas laws, molecular formulas, and molecular weight
(3) Quantitative description of chemical reactions; the meanings of equations; writing, balancing, and interpreting equations; mole and mass relations
(4) Experimental methods for the study of reactions; balances and weight relations; solutions, concentrations, and volumetric measurements; gases and gas laws (to carry through the two years)
(5) Gravimetric measurements

2. Descriptive chemistry

A. The chemistry of carbon and its compounds, "organic chemistry"
(1) Basic principles and concepts, chemical formulas, functional groups, structure, isomerism, resonance
(2) Chemistry of functional groups
a. Hydrocarbons
b. Alcohols, alkyl halides, and ethers
c. Aldehydes and ketones
d. Carboxylic acids and derivatives
e. Nitrogen compounds
(3) Structure and stereochemistry
a. Optical activity and isomers
b. Conformational isomerism
(4) Natural products
(5) Natural and synthetic polymers
B. The chemistry of other interesting and important elements, "inorganic chemistry"
(1) Some of the important nonmetals, e.g., hydrogen, oxygen, nitrogen, sulfur, phosphorus
(2) Some of the metals, e.g., aluminum, copper, iron
(3) Some of the metaloids, e.g., boron, silicon, germanium
C. Broad classification of substances in terms of reactions
(1) Acids and bases in the most general sense
a. Concepts of acidity
b. Role of solvent in determining acidity
(2) Coordination complexes
a. Coordinate bonds
b. Chelate effect
c. Chelating agents
(3) Nonaqueous solutions and reactions
(4) Organic functional group analysis
a. Outline treatment of common functional groups and their estimation
b. Molecular weights by end-group analysis

3. Physicochemical principles, especially those in analytical methods

A. Equilibria in solution and between phases
(1) Acid-base equilibria
a. Weak acid-sodium hydroxide system; standard titration curve; graphical and algebraic representation of species present at various stages of titration
b. Weak base—hydrochloric acid system
c. Zwitterion system—isoelectric point
d. Buffers and buffer capacity
(2) Phase equilibria, solubility, and mass action
(3) Titrations in nonaqueous systems
a. Comparisons with aqueous systems
b. Effect of added water on nonaqueous systems
c. Titration of weak bases
d. Titration of weak acids
B. Electrochemistry
(1) Electrolysis and conductivity of solutions; relation to chemical reactions
(2) Static electrochemical measurements
a. Cell reactions—mass and electrical balance for half reactions, cell representation for a chemical reaction
b. Sign conventions
c. EMF calculations
d. Potentiometric titrations
e. The concentration cell
f. Definition of pH
(3) Dynamic electrochemical measurements
a. Mass transfer—diffusion, convection, migration
b. Achieving diffusion control
c. Techniques — chronoamperometry, polarography
C. Energetics in chemical reactions
(1) Energy changes—calorimetry
a. Basic notions of thermodynamics—enthalpy, entropy, and free energies
b. Driving force of a chemical reaction
c. Appropriate use of suitable tables of free energies of formation, enthalpies of formation, and absolute entropies
(2) Thermochemistry
a. Combustion, flames, and explosions
b. Relationships to equilibria and temperature dependence of equilibria
D. Kinetics—dynamics
(1) Quantitative description of the rate at which reactions occur
a. Factors influencing the reaction rate—concentration, pressure, temperature
(2) The relation between "mechanisms" and overall stoichiometry
a. Kinetics and equilibria

The Young committee outlined this two-year chemical technology curriculum

Chemistry core		**28 to 30 units**
Technical option		**8 to 10 units**
Chemical engineering Industrial chemistry Materials science Radiation science Biological science Electronics and instrumentation	Select one field	(8 to 10 units)
Related subjects		**23 to 24 units**
Physics		(8 units)
Mathematics, including a brief introduction to calculus ideas		(8 units)
Communications, including composition, speech, and technical report writing		(6 units)
Laboratory workshop		(1 to 2 units)
Other subjects		**9 to 12 units**
Subjects required to meet local requirements in social sciences, humanities, arts, health, and physical education		(varies)
Economics, business, industrial organization and management, etc.		(varies)
RECOMMENDED TOTAL NUMBER OF UNITS		**68 to 72 units**

- E. Atomic and molecular energy levels and spectra
  - (1) Energy states associated with rotation and vibration of molecules
  - (2) Electronic states
  - (3) Spin-orientation states
  - (4) The relation of these states to spectra

4. Nuclear and radiochemistry

- A. Nature of radioactive decay, rate laws, half-life, and energies
  - (1) Safety precautions
  - (2) Typical instrumentation
  - (3) Nature of measurements and correction
    - a. Statistics of counting
    - b. Self-absorption
    - c. Geometry effects
  - (4) Tracer techniques
  - (5) Isotope dilution analysis
  - (6) Neutron activation analysis

5. Instrumentation

- A. Electronics—introductory
  - (1) Electromagnetic radiation absorption instruments
    - a. Sources of radiant energy
    - b. Resolution devices
    - c. Detection devices
    - d. Amplification and readout
    - e. Commercial instruments

6. Separation

- A. Separation and purification
  - (1) Melting-freezing methods (liquid-solid partitioning)
    - a. Melting point of a single substance
    - b. Freezing point of mixtures
  - (2) Distillation methods (liquid-vapor partitioning)
    - a. Vapor pressure and boiling point of single substances
    - b. Boiling point—composition relations
    - c. Fractional distillation
  - (3) Extraction (liquid-liquid partitioning)
    - a. Distribution law
    - b. Multiple extraction
  - (4) Chromatography
    - a. Gas-liquid chromatography: theoretical principles; factors determining retention; instrumentation: carrier gas, columns, solid support, liquid phase, sample introduction, and detectors; qualitative analysis; quantitative analysis
    - b. Liquid column chrom tography, types of a sorbents and liqu phases
    - c. Plane chromatograph paper chromatograph and zone electrophore
    - d. Ion exchange metho types of resins, tec nique of ion exchang and typical applicatio
    - e. Gel-permeation chrom tography, types of ge technique, and applic tions

7. Characterization[*]

- A. Electromagnetic radiation a its interaction with matter
  - (1) Nature of electromagnet radiation
  - (2) Interaction of electroma netic radiation with matt
    - a. Spin state changes (nuclear, electrons)
    - b. Rotational energy changes
    - c. Vibrational energy changes
    - d. Electronic energy changes
  - (3) Absorption, emission, stimulated emission, and fluorescence
  - (4) Refraction and refractiv index
  - (5) Rotation of plane polarize light
    - a. Optical rotatory dispersion
- B. Quantitative analysis by absorption of electromagnetic radiation
  - (1) Beer's law
  - (2) Multiple component systems
  - (3) Photometric error
- C. Applications of UV, visible, and infrared spectrophotometry to molecular systems
  - (1) Absorption cells
  - (2) Solvents
  - (3) Solution preparation
  - (4) Wave length calibration
  - (5) Spectra interpretation
  - (6) Electronic spectra (correlations of structure and spectra)
  - (7) Vibrational spectra (correlations of structure and spectra)

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[*] It is quite possible that facilities will not b available to permit a student to have experienc with these devices in the laboratory. However we feel that these areas are important to th current practice of chemistry. Any student entering a chemical area must have some familiarity with their existence, basic principle of operation, and possible application, if only through exposure to films, photographs, and lecture materials, and contact with data a generated by these techniques, i.e., actual mas spectra, NMR and EPR spectra, IR and UV spectra.

    (8) Fluorescence
D. Applications of emission and absorption to atomic systems
    (1) Sample devices (arc, spark, flame)
    (2) Line sources
    (3) Methods of quantitative measurement (calibrations, etc.)
    (4) Scope of applications
E. Nuclear magnetic resonance
    (1) Nuclear properties of energy states in a magnetic field
    (2) Resonance phenomena (absorption and relaxation)
    (3) Interpretation of spectra in terms of molecular structure
    (4) Chemical shift
    (5) Spin-spin splitting
F. Electron spin resonance
G. Mass spectrometry
    (1) Basic relationships of charged particles moving in magnetic field
    (2) Instrumentation
        a. Schematic
        b. Sorting by path curvature
        c. Sorting by time of flight
        d. Double focusing
    (3) Ion production and cracking patterns
    (4) Applications
        a. Identification by molecular weight (isotope abundance effects on molecular peaks, use of mass defects)
        b. Identification by cracked patterns
        c. Analysis of multicomponent mixtures
H. X-ray emission, absorption, and diffraction

8. *Laboratory presentation and testing of data*

A. Elementary statistical tests for significance, accuracy, and reliability
B. Presentation of data in tabular and graphical formats
C. Written reports of experimental studies

9. *Safety in the chemistry laboratory*

Organization. As indicated in the curriculum content, we do not feel it sound to prescribe a particular sequence of courses of particular content. We do suggest one possible organization of the topics enumerated above. This outline follows the currently well-established subdisciplinary lines. We would urge the eventual incorporation of the innovative integrated curriculum into the chemical technician training program. Such an innovative curriculum is represented by the "Hammond Curriculum" (C&EN, Nov. 14, 1966, page 48) and by the thinking of several members of the present committee, and of Prof. R. Martin Stiles.

A "core" program is visualized of two years duration consisting of six one-semester courses, and the following outline keeps this committee's conclusions within the presently accepted well-established framework.

1. Basic chemistry
    a. Essential notions of atoms and molecules and stoichiometry
    b. Laboratory work introducing quantitative techniques for the preparation, separation, and characterization of simple "inorganic" substances, gravimetric and volumetric techniques
2. Descriptive Chemistry I: "organic chemistry"
    a. The functional groups, structure and reactivity
    b. Laboratory work in synthesis, separation, purification, and characterization using all techniques practicable at this level: extraction, distillation, chromatography, simple physical measurements
3. Descriptive Chemistry II: "organic chemistry"
    a. Structure and reactivity, natural products.
    b. Laboratory work continuing previous studies, perhaps directed toward natural products wherever possible
4. Descriptive Chemistry III: "inorganic chemistry"
    a. A broader perspective of the periodic table, nuclear chemistry, and radiochemistry
    b. Physicochemical principles related to electrochemistry, radiochemistry, and "inorganic chemistry"
5. Equilibria in solution and analysis
    a. Physicochemical principles related to equilibria, solubility, acid-base relations, buffers, complex formation
    b. Laboratory work in quantitative applications of these principles
6. Instrumental techniques
    a. Molecular structural principles appropriate to comprehension of advanced spectral methods, e.g., infrared, NMR, EPR
    b. Laboratory work in electrochemistry, applications of all instrumental techniques to both "organic" and "inorganic" systems

The present committee concurs with the recommendations of the previous committee as far as technical options are concerned and has made no further study of this area.

In mathematics and physics we refer to items 15 and 16 from the report of the earlier committee.

> "15. *Physics:* The physics course should include what is commonly included in the general physics or technical physics course. It should make use of the mathematics included in the curriculum and include laboratory work.
>
> 16. *Mathematics:* The mathematics course should include topics commonly found in intermediate algebra, plane trigonometry, mathematical analysis, statistics, and slide rule courses and also include a brief introduction to the ideas of calculus. It may also include the use of modern calculators and a brief introduction to computers."

We would delete the reference to specific texts in the physics section. In the mathematics section we would iterate strongly the necessity for a sound math background before entering the technician curriculum program. The committee stresses the importance of noncalculus course content during the two-year program, *but* recommends that where practical and possible, an introduction to and some applications of calculus be included.

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CRITIQUE

R. A. Boehler
Nalco Chemical Company
Chicago, Illinois

In essence, I am in agreement with the American Chemical Society goals for training of chemical technicians as presented by Dr. Carleton Roberts. However, I do hold some personal reservations on the attainment of these goals. Currently, the ACS, together with its various committees associated with technician education, is bogged down with defining a curriculum, establishing a standardized text, combatting the shortage of qualified teachers and last, but not least, defining the responsibility of the ACS towards its newly created offspring.

We, as a Society, have been attempting to formulate an educational program which is the panacea for all concerned. At some point, we must face the reality that such a program would be so complex with details that it would never get under way. It has been an American tradition that as needs arise, needs are fulfilled. The need for qualified chemical technicians has been expressed by industry, government and academic institutions. This need will be fulfilled with the joint cooperation of the ACS and our nation's educators.

Mention is made of a pilot program for textual materials designed for training chemical technicians. Unfortunately, there is no identification of the proposed authors of these texts. I am not convinced that one set of formalized texts is the answer to the technician training program. The ACS should establish the concepts which are to be taught and leave the text selection to the department head or instructor. This may impose an immediate burden upon the instructor, but one that is not insurmountable. If we do not have enough confidence in our educators to fulfill their role as qualified instructors, then we might just as well abandon the technician training program. Only by screening and putting to task a variety of chemical technician training programs can an adequate curriculum be truly evaluated. In all probability this curriculum will have several options. When a particular curriculum becomes universally acceptable or "standardized" there will be an ample supply of authors to write unified texts for the curriculum.

Several representatives of colleges presented their chemical technician training program here today. I was very much enlightened by programs now in existence to alleviate the technician shortage. These programs may not represent the ultimate; however, they do provide some tangible evidence at meeting a critical problem head on.

The Technician Curriculum Committee made an important decision by defining the technician program as an occupational or terminal curriculum. It was a decision that had to be made. The American Medical Association made a similar decision with respect to medical technologists years ago. The impact of such a decision on attracting students can only be conjectured. If one keeps in mind that the goal of the technician program is to prepare better qualified technicians, then the Committee's decision not to transfer credits from a technician program to a Bachelor of Science in chemistry was correct. However, I do not believe that the technician curriculum should be so narrow or restricting that certain credits could not be applied as full or partial requirements towards a degree in chemistry or other discipline areas.

One facet of this educational program has been passed over rather lightly. This is the concept of selling the technician program to the student. At the student level, the chemical technician program is in direct competition with other technician programs, trade schools and unions, just to mention a few. This selling program should start at the seventh and eighth grade level and continue through the high school years. The concept of what a chemist does and the role of the chemical technician should be defined with visual aids, literature, lectures, tours, and planned guidance sessions. The ACS must continue to do everything within its power to upgrade the prestige and status of the chemists in all phases of industry, teaching, academic, and government work. The chemical technician should possess a feeling of pride in accomplishing his work and being associated with the chemical profession. If this concept is not conveyed to the student, we may find ourselves with an ideal curriculum but unopened "standardized" texts. I cannot help but call to mind a recent news telecast on a Chicago station during a siege of sub-zero weather. The telecast interviewed two young men from a group of about twenty-five. These men had been standing in line for two days to take an examination for qualifications as an apprentice in training for a local electrical union. I wonder how many would have been in that line if the training program were for chemical technicians?

From the discussions we have had today, it may be possible to piece together a more meaningful educational program for technicians. It has been four years now since the ACS took formal cognizance of the chemical research technician. Many feel that little has been accomplished since that time. Those who have actually worked on Committees and pioneered this program from its conception know that a great deal has been accomplished. Any step forward in this area is a step in the right direction. A program of this kind, with its many complexities, will not be solved overnight. We must have the confidence in our Society and educational processes and support them in every way possible in order to overcome the educational dilemma placed before us.

Summary of Roundtable Discussions on Chemical Technician Education

Three groups met simultaneously to further discuss the three aspects of technician education presented previously. The following statements are summations of these discussions.

Roundtable #1 - Integrating Chemical Technology with Standard Chemistry Courses
Norman Peterson, Moderator; J. Fred Wilkes, Recorder

1. Some individual colleges have surveyed local industry to ascertain technician needs. The St. Louis Research Council surveyed industry in their area for all types of technicians. They received excellent industrial cooperation and found that the demand for technicians is very great.

2. Three technician levels were suggested:
   a) Routine tasks; requires very close supervision
   b) Less routine; requires more general supervision.
   c) Characterized by -- "Here's the job. Set it up and bring me the results."

   An ACS group in St. Louis has worked on a program for the disadvantaged to provide basic laboratory operator manipulation skills. The goal is to get them into the laboratory, build some motivation and encourage added schooling at night.

   The non-profit St. Louis Research Council serves as an intermediary between schools and industry. It has found a growing demand which promises to stiffle future growth if not satisfied.

3. Advisory Committee members may be obtained by examining survey results to identify persons with strong opinions on curriculum. A committee may result from industry approaching the school. When a program is established, jobs for graduates should be readily available.

4. Extreme difficulty may be encountered by mixing chemical technology students with pre-professional students in advanced courses such as organic chemistry. Corrective factors discussed included separate examinations, expectation of different kinds of achievement and integrating instruments into the organic chemistry laboratory.

5. Colleges committed to training that will keep graduates in the immediate area may not find a chemical technology program worth while. In more industrialized areas, the technology program provides a basic education to produce a supply of good personnel. Specialization in such things as plating, plastic or paint technology is possible.

6. Expectations of the individual differ between the chemist and the chemical technician. Productivity and performance must be measured on a different basis, not in terms of more and less!

7. Three graphical differentiations between professionals and technicians were attempted (Figures 1, 2 and 3). It was emphasized that an "apology complex" has hindered acceptance of technology education as a legitimate part of higher education. The "apology complex" displays itself in many of the verbal definitions and graphical descriptions seeking to identify the technicians as part of the technical manpower team. In part, this results from the general public's lack of knowledge about science and engineering activities. The general public has an outmoded view of science and engineering activities and finds it difficult to see the needs existing for technicians between the craftsmen and the scientist or engineer. The projected picture becomes one where the technician is a second class craftsman (lacking the necessary skills) or a second class scientist or engineer (lacking the necessary theoretical knowledge). However, the technician should be seen as a unique person possessing attributes not possessed by other members of the technical manpower team and enabling him to make unique contributions in certain parts of scientific or engineering work.

Roundtable #2 - **Chemical Technology as a Separate Curriculum**
Charles Hoffine, Moderator; John Forette, Recorder

1. Courses for chemical technicians should be geared to a specific objective - namely - practical laboratory know-how.

2. Larger colleges can sustain multi-purpose programs which include special courses for technicians but this may not be possible in a small school.

3. Special attention and better motivation may enable students that start slow to mature and succeed -- even to continue in BS or BT programs.

4. Separate Physical Chemistry courses are not essential.

5. Mathematics instruction should emphasize essential manipulations!

6. One-year certificate programs may be sufficient for individuals who want only the technical essential in order to get a good-paying job.

7. To accomplish the preceding goals that have been implied, good teachers must be attracted to this instructional area.

8. Advisory committees can be most useful to a department offering chemical technology. The best members of these committees are not personnel or technical service persons, but rather group leaders and people very close to bench work.

9. ACS should explore means of disseminating job opportunities and salary information pertinent to technicians.

10. Laboratory instruction must be made the central feature of technician instruction.

Roundtable #3 - The Role of ACS in Chemical Technology Education
Carleton Roberts, Moderator; Robert Boehler, Recorder

1. ACS should be more active in the technician area and keep the technician perspective.

2. ACS should increase its effort in career guidance.

DIFFERENTIATING BETWEEN SCIENTISTS AND TECHNICIANS

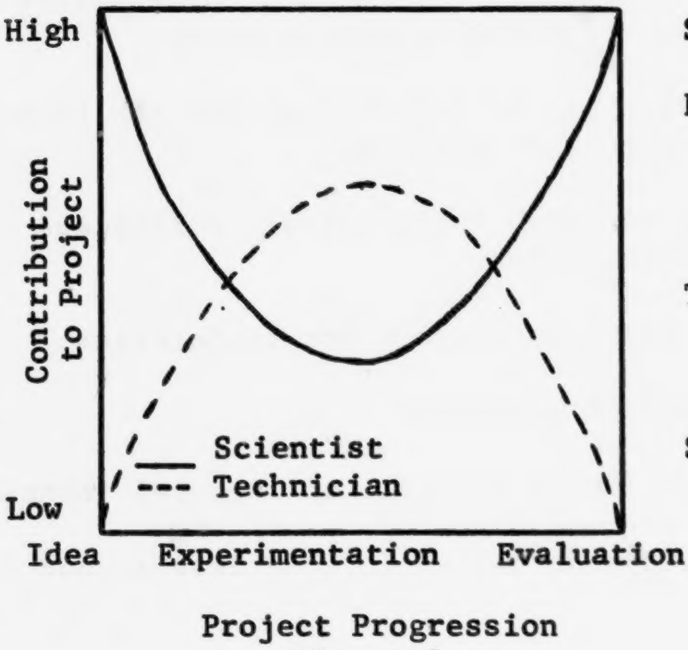

Figure 1

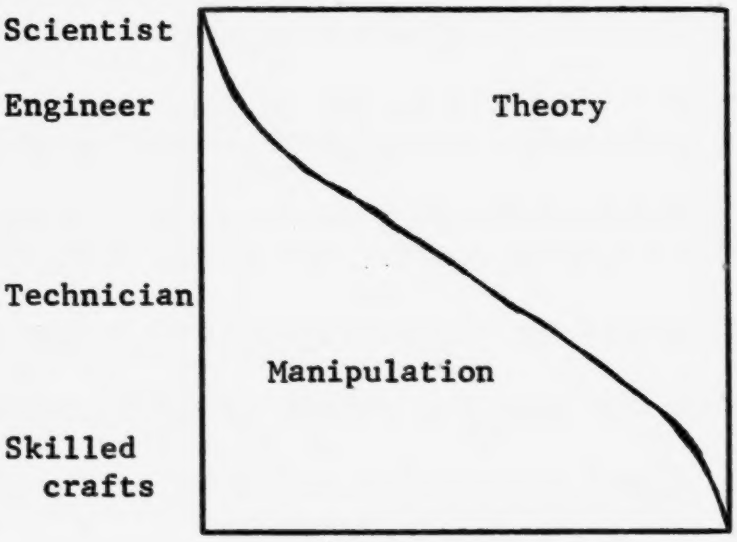

Figure 2

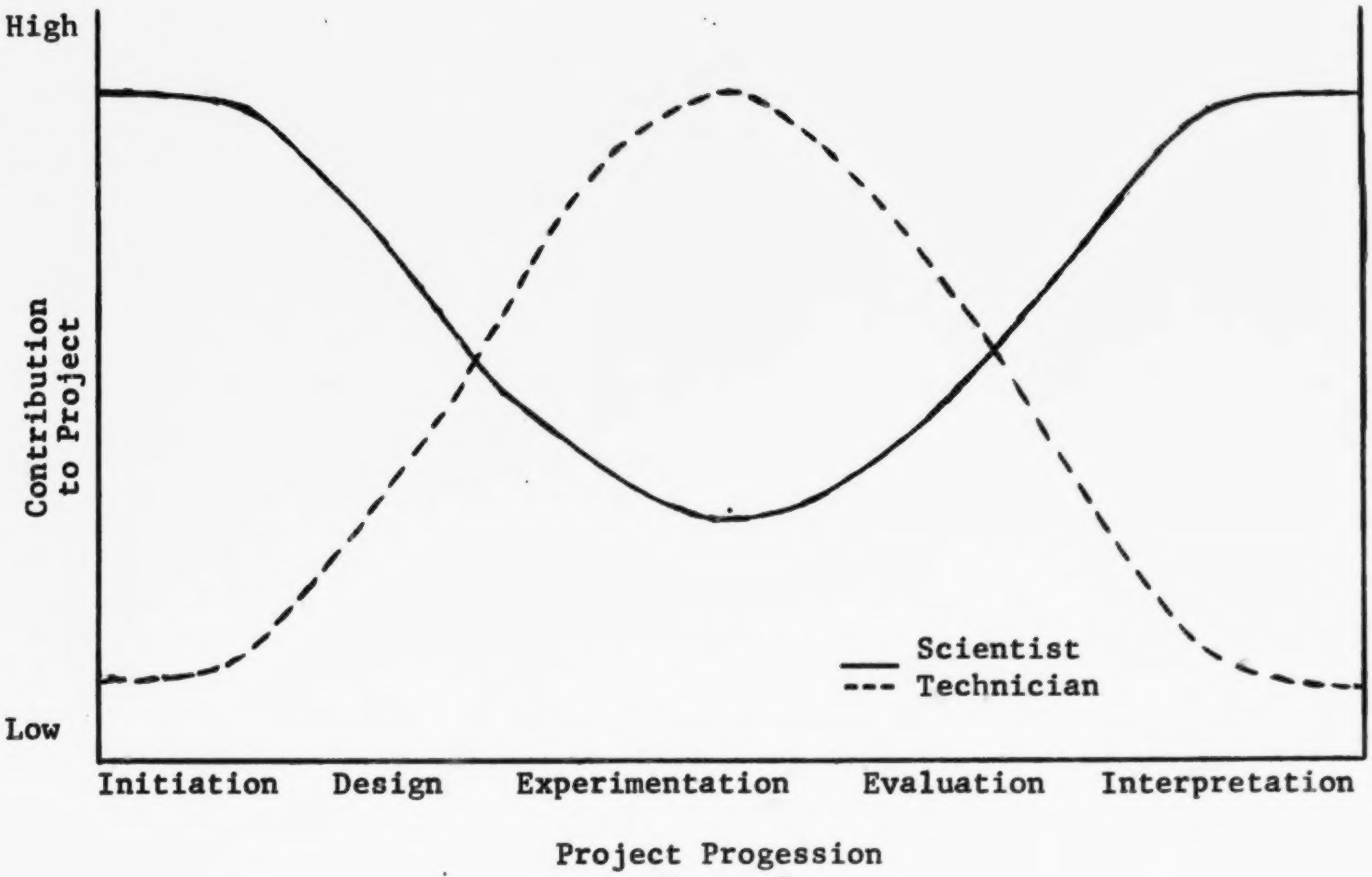

Figure 3

3. Meetings such as these are beneficial to companies and colleges.
4. There was mixed feeling regarding the speed with which ACS should direct attention at four-year technology programs.
5. In cooperation with industry, ACS should stimulate colleges and universities to develop special programs to prepare teachers for technology programs.
6. ACS should do all it can to help standardization of definitions and job titles for technicians although this will be difficult to operate.
7. ACS should definitely have an affiliation category for chemical technicians which could be another bit in the recruitment effort.
8. ACS should not become involved in a certification program for technicians.
9. Technician symposia should be continued at ACS meetings.
10. ACS should investigate the developing high school programs in chemical technology.
11. We need better public relations for chemistry at all employment levels, not just for chemical technicians.
12. ACS should better publicize job openings for technicians - including salaries and careers.
13. ACS should encourage industry to give better support for two-year schools with chemical technology programs.

THE FOUR-YEAR BACHELOR OF TECHNOLOGY PROGRAM

William Lawless
University of Dayton Technical Institute
Dayton, Ohio

The Bachelor of Technology degree is a four year college program designed to enable Associate Degree technicians to continue their education. They are given the opportunity both to continue work in their chosen discipline, and to diversify into other technical areas, as well as to continue their humanistic-social studies. The result therefore is an individual possessing a good foundation in the practical fundamentals of chemistry, a broad view of non-chemical technologies, a strong technical supplement of physics and mathematics, and a rounded cultural supplement of English and the humanities.

The candidate for the Bachelor of Technology program at the University of Dayton must first have completed, or at least be well into, our 2 1/2 year Associate Degree curriculum. Thus, the Associate Degree is an integral and necessary part of the Bachelor's Degree program and forms the basis for it. At the conclusion of his Associate Degree work the student has amassed 37 semester hours of chemistry and chemical engineering, 14 semester hours of physics and mathematics, and 36 semester hours of varied humanistic social studies and related science courses. He has accumulated a total of 87 University credit hours and will need 44 additional hours (about 1 1/2 years) to complete the Bachelor's Degree requirements. Of these 44 hours, 32 are completely elective: 21 technical and 11 non-technical. Possible technical electives include courses from such areas as electrical engineering technology, industrial engineering technology, mechanical engineering technology, mathematics, computer science, biology, geology, and of course, additional chemistry. The non-technical or socio-humanistic work may be taken in virtually any department within the University. Our idea is to provide the student with as much leeway as possible within the framework of contemporary chemical technology as we can discern it. The remaining required 12 hours are composed of 6 hours of English, 3 of mathematics, and 3 of psychology.

An obvious advantage of the Bachelor of Technology curriculum is that we have a more flexible and more highly trained technician. A chemical technician for example with a knowledge of electrical circuitry and/or computer science, and/or statistical quality control, and/or fluid mechanics. But as his technical education has intensified so has his non-technical education, with additional courses in English, history, and the social sciences, and thus he becomes a better citizen - more responsive and more responsible.

Neither is there to be overlooked the prestige and sense of accomplishment attending the achievement of a bona fide four-year Bachelor's Degree. This places the technician in the position of knowing more than just chemistry, and of being able to integrate his chemical assignments with electronics, as in semiconductors; or with mechanics, as in the behavior of fluids; or to have a knowledge of the operation and capability of computers, and to have an understanding of the economics and cost control of production.

Another important feature is that now industry has a technician with a four year degree which means, that as he demonstrates capabilities beyond the requirements of simple, routine work, he can be promoted into more responsible positions far more readily than if he had only an Associate Degree. It means that his job description need not be written so as to limit his scope and duties to just those of relatively simple tasks.

Our policy at the University of Dayton is to supplement the Associate Degree with the Bachelor's. Thus the student specializes first into his chosen area completing the Associate Degree, then diversifies during his Bachelor's Degree work. He cannot receive the Bachelor of Technology Degree without having first completed the Associate Degree requirements.

I might point out that the major difference between the Bachelor of Technology program and a Bachelor of Science program in Chemistry is that the in-depth theoretical coverage found in the BS Degree program is lacking in the BT Degree program. We try to compensate for this by offering a broader coverage of material and emphasizing application. Unlike many Bachelor of Science programs we are not preparing our students for graduate school. We occasionally have graduates who enroll in an MBA program. The Bachelor of Technology Degree with the required undergraduate business courses is sufficient for admission, whereas the Associate Degree is not. I am sure you can see the Bachelor of Technology Degree would make an excellent background for a career in technical sales.

Results of a brief survey of industry in Dayton area revealed that the following salary ranges are presently applicable:

Assoc. Degree	$500 - $610 (per month)
B. T. Degree	$650 - $750 (per month)

We find approximately 85 percent of our Associate Degree graduates going on for their Bachelor's Degree. This figure represents our technical institute as a whole which includes electrical, industrial, and mechanical engineering technologies, as well as chemical technology. Of the current class of Associate Degree candidates in Chemical Technology, all plan to continue for the full four years. We also admit several transfer students holding an Associate Degree from other institutions who desire to work toward their Bachelor's Degree.

While there may be approximately 75 schools granting the Associate Degree in Chemistry throughout the country, there are probably less than ten institutions offering the Bachelor of Technology Degree. Nevertheless, our growing conviction at the University of Dayton is that it is definitely the coming trend in technician education.

The main obstacle seems to be that of making industry and future students cognizant of its potential.

CRITIQUE

David W. Holty
Corn Products Company
Argo, Illinois

The four-year Bachelor of Technology degree program described by Professor Lawless of the University of Dayton was the first example of the four-year training program to come before this symposium. My own reaction is hearty endorsement; but before I tell you why, perhaps I should clarify my assumptions.

I would prefer, all other things being equal, to hire a BT man rather than a BS or BA chemist for a position as a technician. But here I am being a bit selfish, and I am giving prime consideration to the performance and continuity of a man who has chosen a technician's career. The industry employes large numbers of BS chemists in basic research, and I am sure this will always be the case. Large corporations consider their research laboratories as excellent training grounds, and many promising young men move out of the research laboratories into other operations of the company. The attrition out of research is expensive, for new chemists must be brought up and trained to fill the vacancies. Management apparently considers the process worthwhile and the experience in research valuable for young men on the way up.

But the topic here is chemical technicians, and as the leader of a small research group, I can visualize advantages to hiring BT rather than BS chemists. Foremost among these is that the BT, in the act of opting for a technician's training, has served notice that he seeks a technical career. He can be expected to devote all his energies to making a significant contribution to the research effort. His training has been practical, and he has graduated with developed skills that can be immediately useful to his employer. He does not need as much theory as that taught in courses whose orientation is toward postgraduate schooling. The ratio of BS graduates going on to an advanced degree is high, and a principal *raison d'etre* of faculties offering the BS degree is preparation for graduate school. That is why I like Dayton's program; it is a terminal program with all the prestige of a bachelor's degree and all the practicality necessary to enable the graduate to do a good job in his chosen profession. It recognizes the value of a dual program as have many high schools, which offer college preparatory courses and vocational training.

Perhaps I could take a few moments to touch on Dayton's biggest problem; that of interesting more students in the BT program. I believe an effort might be made to acquaint freshmen with the two side-by-side programs. For those who intend to go into industry following graduation, the BT program might have more appeal; for those who hope to continue their studies in graduate school, the BS probably is preferred because it is more theoretical. This is not to suggest that a BT could not make the grade in graduate school; lack of sufficient technical training can be just as serious a handicap in graduate school as lack of theoretical background.

Some of the testimony heard at this symposium indicates that one reason students have not flocked to classes in chemical technology has been a lack of communication to potential students about opportunities. I feel, however, that it is not too naive to suggest that the shortage is also economic in nature. We are told that industry forecasts a tremendous demand for technicians in the next decade.

A question which needs to be asked is "how much is industry prepared to pay for these people?" Society in general faces the same problem finding enough teachers. Everyone agrees that we need to attract more people into the teaching profession, but until salary levels rise we will probably not attract as many as we need.

I also feel we should be a bit self-critical and examine our attempts to encourage others to enter our profession. There is a theory encountered in all studies of organizational structure that all organizations will undergo a constant process of self-professionalization by "upgrading the standards of the profession." I could give examples of this behavior by chemists; ACS accreditation of chemistry departments and their curricula, etc., but the profession best known for these practices is that of medicine. Under the policy of "protecting the public from the shoddy practice of medicine," the AMA protects its interest by rigorously controlling entry into the profession. Admission to medical school gets tougher all the time, new medical schools have a very difficult time getting accredited, and the training of physicians is long, ardous, and a heavy financial burden. It is no secret that if the production of doctors does not keep in pace with the population, the immediate effect is crowded waiting rooms and the enrichment of today's physicians. This is not to indict doctors; I sincerely believe that their concern for the public's well-being is genuine. I simply ask that we be aware of the results of an organization's attempts to upgrade its profession.

I will propose the question whether we too are controlling entry into our own profession. We heard several examples yesterday of how our chemistry courses are becoming tougher, and students are dropping out of chemistry like flies. We heard the complaint that freshman texts jump over descriptive chemistry and present a dry, theoretical body of facts which leaves students cold. We hear of freshman chemistry being used as a flunk-out course; is this to trim enrollment, is it to upgrade standards, or is it possible that we are policing entry into our profession? I think perhaps it is a little of each. I know, for me, the "light" did not really start to shine until my junior year in Organic Chemistry. Surely the light would shine for many more students if the load could be a bit easier in the first year, and standards would not have to suffer. So when we say that we want to encourage more people to enter our profession, I am simply asking that we be honest with ourselves.

Now if we are sincere in our desire to interest more people in a career in chemistry, we face the problem of appealing to the large number of students who must be trained as technicians. I feel that we must not lose sight of the fact that the career of a chemical technician is a worthy goal in itself. As employers, it is admirable that we be concerned that the career offers a chance for advancement, but this does not have to mean that technicians should have to move into sales, management, or other jobs outside of the laboratory. We must be certain that opportunities for advancement are available within the technician's own area of competence. Thus we preserve our own investment, because the technician is happy to stay in research and the turnover in replacements is minimized. In addition, we make a technician's career more attractive to the man, when he realizes that advancement is possible in the very area where he received his basic training.

My final comment concerns the source of chemical technician trainees. I believe we should consider the status of the professional and decide what segment of potential students will consider this career appealing. Offhand, it is possible that the most successful programs in chemical technology will be offered by schools in high population centers. These schools should aim their advertising at those students who are most likely to decide that a technician's career is a desirable goal. One suggestion by Dr. Krimen of Abbott Laboratories was that the black community should be approached. Perhaps training in technology has a place in the Job Corps program. Another potential supply of students is returning servicemen, who often have difficulty working back into the mainstream of civilian life. Most veterans qualify for governmental aid for college training, and they could be encouraged to consider chemistry. In fact, military experience, a combination of ingenuit and contributions to the group effort, seems ideal training for careers as chemical technicians.

CONTINUING EDUCATION REQUIREMENTS FOR CHEMICAL TECHNICIANS

Lewis Krimen
Abbott Laboratories, Inc.
Chicago, Illinois

About twelve years ago Abbott Laboratories recognized the need for well trained chemical technicians. The decision was made at that time to implement a training program that would serve not only our own needs but the nearby industrial community as well.

Abbott management, our Training and Education Department, in particular, contacted the local high school (Waukegan) with the proposal that Abbott would furnish technical assistance regarding the course content and organizing a laboratory for organic chemistry. Abbott would also insure that members of its staff would be available as instructors. The funds were provided through the National Defense Education Act directly to the high school. The program was soon underway and extended to offer programs in Electronic, General Engineering, and Business Data Processing Technology in addition to the original chemistry program.

The program has been and continues to be successful. Abbott still furnishes instructors who are paid by the High School and, with other local industries, provides a committee of advisors to recommend changes in course content in order to insure that new ideas and techniques are made available to the students.

The formal education of an individual, whether he is a technician or a professional, is a matter of one's own initiative at Abbott Laboratories. Company policy does, however, take into consideration that some of its employees do desire more responsibility and the accompanying increased earning potential.

Abbott Laboratories provides motivation to all its employees in the following ways:

1. 50% of the cost of books dealing with job-related subjects is provided by Abbott on Department manager's approval.
2. 80% of an employees tuition is re-imbursed if the student earns at least a "C" in a job-related course.
3. Promotion of chemical technicians at Abbott Laboratories is dependent on their achievement level at accredited colleges, universities and technician training programs.

The company makes available a number of non-credit courses. These courses are usually taught at the college level by Abbott personnel and include subjects such as Microbiology, Organic Chemistry, Polymer Chemistry, Biochemistry, Electronics, Computer Programming, and Mathematics.

Participation in these programs is voluntary and in most instances is not specifically aimed at increasing a technician's proficiency at his particular task -- in fact, it is difficult to assess the value to the individual with respect to his performance. Past experiences have shown that the professionals are usually the ones who take advantage of these programs.

In order to appreciate the company's role in the technician's continuing education, one must understand that the policy regarding the hiring, supervision, promotion and work assignment is well defined.

The sequence and job descriptions for our non-professional personnel working primarily in our scientific division and to a limited extent, in other divisions is as follows:

Technician (Level I)

Supervision:
Works under close supervision of an experienced level III or IV technician or a professional.

Equipment, Procedures and Techniques:
Uses a limited number of instruments, related laboratory equipment, procedures and/or techniques or pilot plant equipment.

Education and Experiences:
High School or equivalent. High School science courses desirable and preferred but not mandatory. No work experience necessary.

Scope:
Works within closely defined limits on specific assignments. Records assignment results in accordance with defined procedures. Deviations from anticipated results will be referred to more advanced technicians, pilot plant operators or supervisors for resolution. Is expected to know assigned procedures and techniques and proper use of equipment but not necessarily their underlying principles.

Technician (Level II)

Supervision:
Works under general supervision of an experienced level III or IV technician or professional.

Equipment, Procedures and Techniques:
Uses several instruments, related laboratory equipment, procedures and/or techniques or pilot plant equipment or will be proficient in the utilization of a single or limited number of complex instruments and/or complex procedures or laboratory techniques.

Education and Experience:
High School or equivalent. High school science courses desirable and preferred. Minimum of 24 months laboratory or pilot plant experience at Abbott or comparable laboratory or pilot plant experience elsewhere. Demonstrated progressive production experience in an allied area at Abbott could be considered in lieu of actual laboratory experience.

Scope:
Works within assignment limits which are not necessarily closely defined. Some latitude is permitted without explicit directions from supervisor. Records assignment results in accordance with defined procedures. Will be familiar with some possible alternatives for resolution of deviations from anticipated results. May identify aspects of assignment results warranting further attention of his supervisor or a professional. Is expected to know assigned procedures and techniques and proper use of equipment and in general terms, their underlying principles.

Technician (Level III)

Supervision:
Works under general supervision. May give guidance and instruction to Level I and II technicians.

Equipment, Procedures and Techniques:
Uses several instruments, related laboratory equipment, procedures and techniques or will be thoroughly proficient in the utilization and understanding of a single and/or limited number of complex instruments, procedures and/or laboratory techniques.

Education and Experience:
High School with additional scientific training beyond the High School level, appropriate to the field of work of the assigned department. Minimum of four years of progressive laboratory experience at Abbott or comparable laboratory experience elsewhere. A minimum of five years of allied Abbott production and/or supervisory experience could be considered in lieu of actual laboratory experience if education and scientific training requirements are met.

Scope:
Works within broad assignment limits and with considerable latitude without direction from supervisor. Records results of laboratory work. Will be familiar with alternatives for resolution of deviations from anticipated results. Will be familiar with alternatives for resolution of deviations from anticipated results. Will be familiar with reference sources for modifying procedures or verifying laboratory results. Identifies aspects of results warranting further attention by his supervisor or a professional and may recommend further courses of action. Is expected to know, thoroughly, assigned procedures and techniques, and utilization of instruments, including in some detail their underlying principles.

Technician (Level IV)

Supervision:
Works under very general supervision of a professional. May give guidance and instruction and/or supervise Level I, II and III technicians.

Equipment, Procedures and Techniques:
Will be thoroughly proficient in the use and understanding of instruments, related laboratory equipment, procedures and/or techniques used within his unit and generally knowledgeable concerning intra and inter-department relationships.

Education and Experience:
High School with additional scientific training beyond the High School level equivalent to two or three years of college training. Minimum of six years of progressive laboratory experience at Abbott or comparable laboratory experience elsewhere or four years of pilot plant experience and two years of laboratory experience. Two years of laboratory experience with five years of allied Abbott production and/or supervisory experience could be considered in lieu of six years actual laboratory experience if education and scientific training requirements are met.

Scope:
Works within broad assignment limits with wide latitude in execution of assignments. May participate in planning an aspect of a project and will implement and carry to conclusion a project phase with a minimum of guidance from professional personnel. May finalize assigned phase of project by written narrative report,

drawing conclusions and documenting results. Will be familiar with reference sources for modifying laboratory procedures or verifying results. Will be able to conduct a search of technical literature relative to planning or carrying out an assignment. Will have a thorough understanding of procedures, techniques, and instruments utilized within his unit, and their underlying principles.

Working in a well equipped chemical laboratory with chemists who maintain their own technical competence, in my experience, is one of the best ways to insure the continuing education of technicians. In many cases, the industrial laboratory is far better equipped than Junior College laboratories, technical schools, and even some universities. For example, how many students are still cutting holes in corks in order to conduct an organic experiment? The technician, after a "basic education" in a well designed formal program, will be able to develop in an "on-the-job" environment under the supervision of a professional who maintains his technical competence.

CRITIQUE

Ronald L. Walling
Milwaukee School of Engineering
Milwaukee, Wisconsin

Abbott Laboratories is to be complemented on its excellent and somewhat unique program for the initial as well as, continuing education of chemical technicians. The recognition of their own and others need for trained technicians coupled with their willingness to take the initiative and act is much needed in other areas of the country.

The relating of training to advancement and subsequent setting up of job descriptions to clearly identify the levels of education, responsibility, and authority show a keen insight to motivating a technician. This same procedure has been successfully employed for about six years at Kimberly-Clark Corporation in Neenah, Wisconsin.

I think most of Dr. Krimen's remarks and concern towards some of the level and practicality of technician training is well taken. I do not believe that two and four year institutions are pushing cork boring to any great extent, having often converted in total to standard taper ground glass equipment.

This, however, is extremely expensive and private schools are often hard pressed to justify the expense, let alone obtain the funds. Often heard is "is it really needed?" In this respect Dr. Krimen's remark is much appreciated. Still, in this same vein it will be hard to justify a Varian A-60 with which to train chemical technicians. This is something a smaller institution (and many larger ones, I suspect) will be hard put to obtain. Here is where industry must work out a very expensive donation program or use their better equipped facilities after hours or on Saturdays. The only Midwestern source for an A-60 to smaller schools is at Argonne National Laboratories. This is only on a limited basis however. A firm such as Abbott might consider a cooperative program between smaller schools and itself for the instruction of both technicians (and some faculty) on this more expensive equipment.

A further suggestion that can help in training technicians is consideration of a cooperative education program directly involving the technician with the advanced instrumentation and equipment not available through a given college. This would not be an easy program to implement, but offers advanced training that is desired in technicians.

One further note to consider is a program which could be made available to technicians. This is, as a technician gains seniority, he may accrue a set number of working days (paid) to be used for advancing his abilities by attending short or accelerated courses pertinent to his area of work and educational advancement. Such a program is now implemented at Kimberly-Clark Corporation (although I do not know to what level technician it applies, if at all). In the end, it will be (at least for private schools) industry who has the final say. Programs may be presented, but must also be funded and justified in terms of student demand. Today these latter two points are often too low.

IS THERE A ROLE FOR ACS IN CONTINUING EDUCATION FOR CHEMICAL TECHNICIANS

Kenneth Chapman
American Chemical Society
Washington, D. C.

Technical obsolescence is a very real threat to every person who deals with science and technology today. In chemistry, it is a problem at every level from the skilled operator to the professional having a Ph.D. degree. In recent years the American Chemical Society has begun to combat this problem for chemists and chemical engineers. The success of the ACS Short Courses program has amply demonstrated the need for continuing education by the professional chemist.

The chemist's problem of technical obsolescence did not develop overnight. For many years, ACS has consistently confirmed its conviction that education must be a lifelong pursuit. By 1964, the intensity of the problem indicated that efforts toward continuing education would have to be made in addition to journal publication, national and regional meetings, speakers tours and local section lecture series. At the 1964 ACS meeting in Chicago, seven of the eight standing committees of the Council discussed technical obsolescence and continuing education. In 1964, 81% of the ACS members responding to a survey recommended that ACS initiate a continuing education program.

The ACS Short Courses program was then developed. Three short courses were given for 260 registrants at the 1965 Spring meeting. Five short courses were given for 600 registrants at the Atlantic City meeting the following fall.

At this early point, it became obvious that too few B. A.'s were able to take advantage of courses given at national meetings. Traveling Short Courses were then arranged so that continuing education could be taken to the chemists. The educational background of the registrants for the traveling Short Courses began to reflect the educational background of the total ACS membership. Today, a Short Course can be scheduled where a need exists and a sufficient number of students are expected to attend. The total number of Short Courses is up to about 40 separate courses with a total of 61 individual sessions being given in 1968.

In 1968, the ACS Education Office initiated a program of Package Short Courses for use by industrial, government or other organizations that employ chemists. By offering a course as a single package to a single purchaser, the Society is relieved of the administrative responsibilities of registering each participant and of having to provide the course site and related services. The saving resulting from this plan is passed along to the purchaser. Hopefully, this will encourage the company to allow a greater number of technical employees to participate.

To add flexibility to the continuing education program, the media of films and audio-tape are being explored. One short course on Interpretation of Infrared Spectra has been put on a four-hour film which has proven extremely popular. Other courses may be made available in a similar format.

Audio tapes are also being explored as an inexpensive means of bringing the expert on a subject to the students. None of the tapes are as yet available for distribution. (The first set of audio-tapes should be available by March 1, 1969.)

The present ACS Short Courses program came into being as a result of an existing need. We must ask if there is also a need for continuing education for technicians. Some evidence is available to demonstrate such a need. I have received letters and telephone calls requesting information on sources of instructional materials for technicians. These information requests have come from approximately fifteen different companies -- typical of the many different types of companies which employ persons having chemical training.

The Technician Affiliation Committee has requested that the ACS Education Office conduct a survey of the chemical industry to determine how broad a need exists for continuing education for chemical technicians. This has not yet been done. I hope that the discussions here will shed considerable light on this subject and help ACS determine its proper role in this area.

One of the first questions that ACS must ask is, "Why should ACS offer continuing education for chemical technicians, who usually do not qualify for Society membership?" The easy and obvious answer is that ACS should not do so. Maybe this is the right answer, but I think we should be certain that it is the right one before we accept it. The ACS is an educational and scientific society whose several purposes include advancement of the science of chemistry, improvement of the qualifications and usefulness of chemists, and fostering education and the public welfare. To accomplish these purposes, it may well be that the Society has a mandate to provide continuing education for technicians. In addition, this may provide an indirect service to those many Society members who would benefit by having better qualified technicians available.

The ACS Short Courses program has demonstrated that a national Society can successfully respond to member needs in continuing education. This type of effort, concentrated in a national organization, can make use of the best available talent and make it available on a broad scale. This would provide some obvious advantages in developing a continuing education program for technicians.

We may find it beneficial to contrast the needs for continuing education of the chemist and the chemical technician. The following points are certainly not all-inclusive and their applicability will vary from employer to employer.

1. Most employers have recognized the needs of chemists to keep up-to-date, at least in their specialized and closely related fields. Journal subscriptions, in-house seminars, support for college courses and ACS Short Courses are examples. Many employers have done little or nothing for technicians even though the company would gain much by having better trained technicians. Many companies do not reimburse technicians for college courses and offer few incentives to encourage technicians to read books and periodicals that would really benefit them.

2. Chemists can usually find support for undertaking activities which constitute continuing education (e.g., attending ACS meetings). They usually have a strong sense of professionalism and sometimes have the means for undertaking such activities at their own expense. Very few employers will provide support for technicians to travel and most technicians do not have the

necessary professional drive to undertake such activities without employer support.

3. The training of chemists and their continuing education is reasonably well understood. This is well demonstrated by the ACS Short Courses which require certain prerequisites that are easily interpreted by the chemical community so that few chemists take courses for which they have unsuitable backgrounds. Technicians have much more diverse educational backgrounds than chemists. This will make it difficult to design courses and assure that technicians wanting to take the course will have appropriate backgrounds.

What we are saying is that employers have not yet given much encouragement to their technicians to obtain continuing education. Employers have not supported and possibly cannot support any continuing education activities for technicians that require travel. Technicians cannot be expected to have the same attitude toward continuing education as the chemist. Thus, a continuing education program for technicians may well present more formidable development problems than that for chemists.

Those who question ACS involvement in continuing education for technicians would probably emphasize that this is a company responsibility and that companies have adequate personnel for developing and conducting appropriate training programs. Obviously, technicians do not need exposure to the newest ideas at the frontiers of science to do their work well.

The impressions I have received from company training programs for technicians is that even the most comprehensive programs tend to prepare individuals to work in specific areas and this training stops after a couple of years following initial employment. At that point, the technician must depend solely upon himself and the informal efforts of those around him to improve his competence. In some situations, this may be as near to the ideal as could ever be desired. However, in most of the situations I have observed, the pressure differential needed for osmotic-type learning to occur is simply too great. In such a situation, the technician will continue to improve his skill, but his lack of understanding of the principles involved may have much greater importance when that skill is no longer needed and his employer finds that retraining for a new assignment takes much more time and money than it should.

Availability of appropriate materials may encourage many employers to provide regular continuing education activities for technicians. Small employers might become able to encourage continuing education for technicians for the first time. Companies that have existing programs may be able to further strengthen present training programs through use of materials ACS might provide. We would also hope that feedback from such use would help improve the materials and strengthen the program.

We should now take a more specific look at the problems that ACS might face in providing continuing education for technicians.

Early consideration would need to be given to whether ACS would limit itself to chemistry instructional materials or also provide instructional materials in other traditional areas such as physics, mathematics and technical communications. Although we might expect ACS initially to restrict its activities to the area of chemistry, it might eventually prove desirable to provide instruction to other are especially if no one else were to do so. This would make our job larger and much more complex.

"Design the program to provide what the individual will need to get into part-time study leading to B.S. in Chemistry." This will be one of the first suggestions made should ACS undertake a continuing education program for technicians. I would like to hear both pro and con responses to such a suggestion. My personal reaction is that I would like this to be an outcome for certain individuals who should become chemists. However, I would hope that the program would be designed to make technicians better as technicians rather than produce frustrated technicians who are unable to become chemists for one reason or another.

To provide a basis for starting discussion on this topic, I will suggest an approach which might be used for an ACS continuing education program for technicians. Let me emphasize that these are only my thoughts and do not represent any official position of the Society.

The first thing we must do is identify the audience to which the materials will be directed. I suggest that the chemical technician audience is a group which contains individuals whose background varies from less than completion of high school to those whose knowledge of a specialized area is equal to that of many professionals. To avoid being spread too thinly, we should initially consider restricting our efforts to preparing materials for two segments of this continuum. One effort should enable employed persons to attain the minimum qualifications needed to enter part-time chemical technology programs that could be offered by near-by colleges. The other effort would enable technicians having a general background equivalent to that of the two-year chemical technology graduate to develop a better understanding of the specific field of chemistry in which they are working and develop a greater breadth in chemistry.

I believe that the role of ACS in this continuing education effort would not be identical to the present Short Course program. I think that ACS would prepare instructional materials and make use of various media including programmed instruction, films, and tapes. Essentially, packages of materials would be prepared and their use would need to be supervised by the sponsoring group which could be an ACS local section or the employer. ACS might have to develop a Short Course for the people who would be supervising the use of the materials, but it would not be in direct contact with the student.

The ACS efforts might involve the following steps:

1. A decision would be made to develop a continuing education package for technicians.

2. A well-qualified individual would be found to plan the package and be responsible for its assembly.

3. The package would be developed, including all necessary materials such as films, tapes, etc.

4. The package would be made available to appropriate interested groups. Texts and expendable materials would be retained by the technicians. Non-expendable items could be purchased or returned to ACS.

5. Regular evaluations would be made to keep the package up-to-date.

This approach requires that the sponsor provide the facilities and any instructors that might be needed. The sponsor would determine the schedule based upon general information that ACS could furnish. The sponsor could use the package as an individual offering or make it part of a larger program but would assume full responsibility for planning the program.

It is obvious that an ACS effort for continuing education for technicians can only be undertaken if the need appears great enough and if sufficient interest and resources exist to make a success of the effort.

CRITIQUE

J. Fred Wilkes
Dearborn Chemical Company
Chicago, Illinois

Mr. Chapman has posed several interesting challenges, both to the American Chemical Society and to the chemical educators. There is no doubt that the educational background of technicians will vary widely, making it difficult to develop materials for continuing education which will be broadly acceptable. Then, too, we must consider the responsibilities of the existing two year colleges, the facilities and trained educators which they offer, and avoid usurping those areas which rightly should be theirs to develop. Therefore, it seems to me that the initial efforts of the Society toward continuing education for technicians cannot be made independently, but must go forward in full cooperation with chemistry (science) faculties of the colleges, and with the industry leaders who are sensitive to the present and future needs for trained personnel and their continuing education. There are no doubts at all in my mind that continuing education for technicians is a must, just as it is for their more professionally trained colleages.

Two potential areas of efforts have been outlined by Mr. Chapman. The first of these -- training to provide minimum qualifications needed for entry to part-time chemical technology programs offered by near-by colleges -- seems to better fit the charters of the two-years colleges than it does the areas of competence offered by the Society. However, efforts by the Society to aid in defining scope of such training programs, and in preparing suitable instructional materials to be made available to the colleges would be appropriate. The second effort -- to upgrade present technicians and broaden their understanding of their fields -- clearly poses a challenge, and a mandate to the Society. I believe the Society is well qualified to develop instructional materials, using all practical media, and should make these available both to colleges, industry, and other sponsoring groups.

To expand on the idea of continuing education, I wish to explore some of the ways in which local sections (and Divisions) of the American Chemical Society can contribute to the upgrading of chemical technicians. At present, the Society has nearly 170 local sections with a membership exceeding 100,000. All offer a wide variety of programs designed to keep their members up to date, and in touch with advances in chemistry. These activities include monthly technical meetings, many special topical group meetings, short courses, lecture series, expositions, joint meetings and symposia, plus educational, public and professional relations projects. Not so well known is the fact that chemical and chemical engineering technicians and high school science teachers not eligible for Society membership can participate in these activities at minimum expense, through becoming Affiliates of the Sections (or of one of the 25 Divisions of the Society). The nominal cost of Affiliate status (generally $2.00) is within the reach of technicians, and makes available many opportunities for self-improvement.

A Local Section (or Division) Affiliate can take advantage of all the benefits enjoyed by members, and many of the privileges. While Affiliates may not hold elective office in the Section (or Division), they are not otherwise restricted. Here are some of the activities in which Affiliates may participate:

Regular monthly meetings, which present outstanding speakers on timely topics. Special topical group meetings, including those designed for technicians. Short Courses; lecture series; and other continuing education offerings. Social events, outings and plant trips sponsored by the Section. Availability of local section publications. Reduced rates on Section events, the same as received by members.

The opportunity to make both social and business contacts with others in the industry, and to exchange viewpoints and ideas with those having allied interests should not be overlooked. Since a technician generally is not qualified for Member (or Associate Member) status, which requires certain minimum educational background, he is not restricted from appearing on Society programs as author or coauthor of technical papers. He also can have access to Society publications, or subscribe to journals of his choice. He can appear on Technician Symposia at national meetings.

Recognizing that chemical technicians may not feel at ease at meetings where most of the participants are professionals, and where the program topics often may be very complex, the Local Section Activities Committee is encouraging the formation of Chemical Technician groups, under sponsorship of local sections, and organized with the same framework as other topical groups. These Technician groups can be tailored to the needs and interests of the technicians, with full financial support to aid in programming and mailings and other backing of the Section. We encourage these groups to set up their own organization, elect their own officers, and do their own programming with guidance and support as needed, by the parent Section. Similar topical groups for high school teacher affiliates also are encouraged. Generally, a member of the section is appointed as liaison representative of the Technician group on the Section's Executive Committee, to keep the Section informed of the progress and needs of the Technician group. Naturally the technicians are not excluded from regular meetings of the Section and are encouraged to take part in all its activities. However, they do operate autonomously within the framework of their own organization, where they are given additional opportunities for active participation with others having allied interests and similar experience background.

Many Sections now are operating very successful Technician groups, as part of their Topical Group programs. The Chicago Section has a large Technician Affiliate Group, which is continuing to grow. They are offering selective programming for technicians on topics of their choosing, and have enjoyed large attendance - often well over 100 at these meetings. Operation of their own group keeps the technicians from losing interest, or feeling that the topics to be discussed will be over their heads. By participating in both the technician programs and the main meetings of the local sections, the horizons of the technician affiliates can be broadened and they can be encouraged to continue with their education -- to keep up-to-date by means of short courses and other Section activities.

Special interest groups for high school science teacher affiliates are equally valuable, and should be encouraged as a means of bridging the gap between those in the chemical profession and the high school teachers, who can strongly influence choice of careers by their students. Teachers should be given the same opportunities for updating!

Summary of Roundtable Discussions on Continuing Education for Technicians

Three groups met simultaneously to further discuss the three aspects of continuing education for technicians presented previously. The following statements are summations of these discussions.

Roundtable #1 - The Four-Year Bachelor of Technology Program for Technicians
William Lawless, Moderator; David Holty, Recorder

1. The Bachelor of Technology is a very new development in American Higher Education. As a result, educators and industrial representatives find it difficult to evaluate the curriculum or its products.
2. There may be sufficient reasons to justify three formal levels of training; one-year certificate programs, two-year Associate of Science programs and four-year Bachelor of Technology programs.
3. Emphasis was given to the concept that a technician position is a career position and should be discussed and publicized as such. It must not be considered as a terminal position.
4. At the Bachelor of Technology level, there should be no union problems that are not already present where professionals are unionized. Union problems will be more frequent at the Associate of Science degree level and will usually be prevalent at lower educational levels.

Roundtable #2 - Continuing Education Requirements for Chemical Technicians
Lewis Krimen, Moderator; Ronald Walling, Recorder

1. Use of new instruments or techniques and development of new product lines frequently demand considerable retraining or up-dating of technicians.
2. Employers are presented with both benefits and losses when conducting continuing education programs. It was felt that employers would benefit more by overtraining than they would lose.
3. Some employers conduct in-plant courses at all levels and encourage their personnel to participate in them.
4. The Dow Chemical Company interests students in science careers by conducting science seminars.
5. Much more attention needs to be given to the continuing education requirements of less than outstanding theorists and the other laboratory personnel.

Roundtable #3 - The Role of ACS in Continuing Education for Technicians
Kenneth Chapman, Moderator; J. Fred Wilkes, Recorder

1. Since it is more expensive when a chemist makes a mistake, the chemist may need continuing education more than the technician. However, since technicians have less background than the chemists, they may be in greater need of continuing education early in their careers. Night schools may be an excellent source of appropriate courses for continuing education purposes.

2. Old style concepts of course materials and presentation must change. Two-year colleges may be more adept at providing the right kind of continuing education programs than the universities.

3. Dial access systems for both audio and visual materials should revolutionize continuing education approaches. Among the colleges mentioned that are conducting programs using various media approaches were Hamline University, University of Colorado and the University of Illinois. It was suggested that many colleges may be unable to prepare the necessary software and that ACS may be in a position to do so.

4. If ACS becomes involved in this area, improvement of verbal and written communication skills should be included in the continuing education package.

5. Most materials ACS could offer in this area should be designed for group instruction. The offerings should be heavily applications oriented. The technicians must be convinced that the material is needed and is important.

6. Industry has not generally recognized the two-year colleges as having extensive potential for continuing education programs.

7. Industry has begun forming organizations, job descriptions and pay scales for technicians in spite of the continuing lack of two-year college trained technicians. Too few of these people have been available for many companies to realize the potential contributions such people can make. Industry should be informed of the sources of technicians.